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THE TRANSACTIONS

OF THE

ACADEMY OF SCIENCE

OF

ST. LOUIS.

VOL. VI.

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THE

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VOL. VI.

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LIST OF MEMBERS REVISED TO JULY 1, 1895.

Alden, Jno.....1100 N. Main st.
Alt, Dr. A.....3033 Locust st.
Allen, E. T .....Wainwright Bldg.
Adams, Dr. Wellington.....516 N. Garrison av.

Barck, Dr. C .....2715 Locust st.
Bartlett, G. M.....215 Pine st.
Bagnall, E. J.....3727 Finney av.
Baumgarten, Dr. G.....2643 Chestnut st.
Bakewell, Paul..... .....304 N. 8th st.
Bernays, Dr. A. C.....3623 Laclede av.
Bartlett, La Roy.....3021 Eads av.
Biebinger, F. W.....1421 S. 11th st.
Barnard, Geo. D .....47 Vandeventer pl.
Blair, Albert..... .....902 Union Trust Bldg.
Boogher, Jno. H.....320 Commercial Bldg.
Boeck, Adam..... 3706 Delmar av.
Bouton, Chas. L.....Cambridge, Mass., 92 Wendall.
Brennan, Rev. Norton S.....1414 O'Fallon st.
Brookings, Robt. S.....2329 Lucas pl.
Brown, Daniel S.....2212 De Kalb st.
Bryson, Dr. J. P.....209 Garrison av.
Burroughs, W. S.....240 Dickson st.
Bremer, Dr. Ludwig..... .....3723 W. Pine st.
Busch, Adolphus.....Busch pl.
Bailey, Chas. H.....87 Vandeventer pl.
Bliss, Dr. M. A .....4929 Lotus av.

Carr, Paschall.....Equitable Bldg.
Casey, Jno. F.....322 Pine st.
Carpenter, Geo. O., Jr.....Russell & Compton av.
Chauvenet, Louis .....4129 Washington av.
Chouteau, Chas. P.....918 Security Bldg.
Chaplin, Winfield S.....3636 Pine st.
Coulter, Jno. M.....Lake Forest, Ill.
Crunden, F. M..... .....3749 Laclede av.

Churchill, Fred. A., Jr.....1110 St. Charles st.
Curtman, Chas. O., M. D.....3718 N. 10th st.
Cushman, Dr. Allerton S.....603 Garrison av.
Campbell, Dr. Given, Jr.....1005 N. Taylor av.
Comstock, Dr. T. G.....3401 Washington av.
Chase, Dr. E. C.....3325 Morgan st.
Collins, Robert E .....3811 Westminster pl.
Call, R. Ellsworth.....137 Walnut st., Cincinnati, O.

Davis, H. N.....56 Vandeventer pl.
Dameron, E. C .....83 Vandeventer pl.
Douglas, A. W .....Care of Simmons Hdwe. Co.
Drake, G. S .....Boatsmen's Bank.
Duenckel, F. W.....1821 Schield av.
Durant, Geo. F .....9 Benton pl.
D'Oench, Richard.....2205 Sidney st.
Dodd, S. M.....Amer. Central Bldg.

Eliot, H. W.....2635 Locust st.
Eliot, E. C.....5468 Maple av.
Engleman, Dr. G. I .....3003 Locust st.
Engler, E. A .....Washington University.
Erker, A. P..... .....617 Olive st.
Evers, Dr. E .....1861 N. Market st.
Ewing, Dr. A. E..... .....518 N. Garrison av.
Espenchied, Mr. Chas.....3500 Washington av.

Fairbanks, J. W.....3134 Morgan st.
Fischell, Dr. W. E.....2647 Washington av.
Fletcher, Wendall C.....1045 Goodfellow av.
Fry, Frank R.....2610 Locust st.
Forbes, C. A.....Champaign, Ill.
Frankenfield, Dr. H. C.....U. S. Weather Bur., 9th & Olive.
Fordyce, John R.....3634 Washington av.

Grindon, Joseph, Dr.....509 Ware av.
Green, Dr. Jno .....2670 Washington av.
Gray, M. L.....509 Chestnut st.
Gregory, E. H.....3525 Lucas av.
Goodman, C. H.....3329 Washington av.
Glasgow, Frank A.....2608 Locust st.
Glasgow, Dr. Wm. C .....2847 Washington av.
Graham, B. B.....3500 Morgan st.
Gruner, Philip.....1930 Virginia av.

Hardaway, Dr. W. A.....2922 Locust st.
Haarstick, Henry C.....Main and Walnut sts.
Hambach, G.....Washington University.
Heller, Otto.....Washington University.
Herthel, Adolph.....1739 Waverly pl.
Hammon, T. H .....Weather Bureau, City.
Hitchcock, H.....54 Vandeventer pl.
Hicks, F. C.....Columbia, Mo.
Holmes, J. H.....3810 Page av.
Hodgman, C..... 300 N. 4th st.
Hummel, Chas.....2621 Eads av.
Harrison, Edwin .....3747 Westminster pl.
Hitchcock, A. S.....Manhattan, Kansas.
Hurter, Julius.....2346 S. 10th st.
Hulbert, Dr. G.....3026 Pine st.
Hirschberg, F. D.....S. W. cor. of 3rd & Pine st.
Hartmann, Rudolph.....2020 Victor st.

Ives, Halsey C.....Museum of Fine Arts.

Johnson, J. B.....Washington University.
Johnson, R. D. O.....Ulvine, Mo.
Jewett, E. C..... .....U. S. Assay Office, City.
Johnson, Dr. J. B.....22nd & Locust st.
Joster, E. T..... .....Liggett & Myers Tob. Co.

Kinner, Dr. Hugo.....1103 Rutger st.
Kinealy, J. H.....Washington University.
Kinsman, G. C.....Decatur, Ill.
King, Goodman.....3710 Delmar av.
Kotany, L.....3015 Lucas av.
Holbenheyer, Dr. E .....2006 Lafayette av.
Kribben, B. D.....701 Bank of Commerce Bldg.
Krall, Geo. W.....Manual Training School.
Kromrey, Hugo.....513 Walnut st.
Kaime, D. F.....3717 Delmar av.
Klemm, Richard.....1730 Missouri av.

Lackland, R. J..... ..... 1623 Lucas pl.
Leete, Dr. J. M.....2912 Washington av.
Letterman, Geo. W.....Allenton, Mo.
Leighton, Geo. E.....803 Garrison av.
Leighton, Geo. Bridge.....803 Garrison av.
Lemoine, Dr. E. S.....1622 Washington av.
Lind, Dr. G. D.....Lebanon, Ohio.
Luedeking, Dr. Chas.....Stamford, Conn.

Markham, Geo. D.....2703 Washington av.
Mack, Chas. J.....113 N. Broadway.
Marx, Dr. Ella.....3332 Morgan st.
Meier, Frederick.....1829 Kennett pl.
Miller, C. F.....1751 Missouri av.
Morton, I. W.....Care Simmons Hdwe. Co.
Moore, Robert.....119 Laclede Bldg.
Moore, Dr. W. G.....3041 Easton av.
Madill, Geo. A.....2821 Chestnut st.
Mudd, H. H.....2604 Locust st.
Murtfeldt, Miss Mary E.....Kirkwood, Mo.
Meisenbach, Dr. A. H.....2229 S. Broadway.
McKittrick, Hugh.....2913 Locust st.
Mallinckrodt, Mr. Edw.....26 Vandeventer pl.

Nagel, Charles..... .....2044 Lafayette av.
Nelson, N. O.....8th & St. Charles sts.
Nipher, Francis E.....3017 Thomas st.
Neville, Dr. J. E.....3960 Delmar av.

Olshausen, Geo. R.....1228 Dolman st.
Olshausen, Ernest..... 1115 Rutger st.
O'Reilly, Dr. Robert J.....1722 Washington av.

Parsons, Chas.....2804 Pine st.
Pammel, L. H.....Ames, Iowa.
Pettus, W. H. H.....2834 Chestnut st.
Pegram, Geo. H.....Omaha, Neb.
Pike, S. B.....Amer. Central Bldg., City.
Pell, Alexander.....1023 Park av.
Post, Dr. M. H.....27th & Washington av.
Potter, W. B.....3312 Washington av.
Pritchett, H. S.....Washington University.
Prewitt, T. F.....3101 Pine st.
Pretorius, Dr. Emil.....2013 Park av.
Pulsifer, W. H.....Newton Center, Mass.
Parker, I. H.....400 N. Third st., City.
Purinton, Prof. G. D.....4265 Olive st.
Pickard, Prof. John.....Columbia, Mo.

Ravold, A.....2806 Morgan st.
Rigge, W. F.....St. Louis University.
Ramel, A.....Washington University.
Robertson, Charles.....Carlinville, Ill.

Robert, E. S.....417 Pine st.
Runge, Dr. C. E.....Care St. Louis Insane Asylum.

Schweitzer, B.....Columbia, Mo.
Scott, H. C.....3140 Washington av., City.
Sander, Dr. Enno.....129 S. 11th st.
Sanger, Charles R.....Washington University.
Schneck, J., Dr.....Mt. Carmel, Ill.
Schmalz, Leopold .....2319 S. 18th st.
Schwarz, Dr. Henry.....1723 Chouteau av.
Seddon, James R.....1516 Lucas pl.
Senseney, Dr. E. M .....2829 Washington av.
Sears, Edmund H.....Mary Institute.
Shepley, John F.....3507 Franklin av.
Simmons, E. C.....9th & Washington av.
Smith, Dr. S. H.....3646 Washington av.
Smith, Holmes.....Museum of Fine Arts.
Smith, Jared G. ....Washington, D. C.
Snow, Marshall S.....Washington University.
Sheldon, J. L.....4313 Olive st.
Speck, Charles.....1206 Morrison av.
Spigelhalter, J .....2166 Lafayette av.
Spencer, Dr. H. H .....2725 Washington av.
Starr, J. E.....Box 71, Atlantic City, N. J.
Stevens, Dr. Chas. D.....1749 S. Grand av.
Sluder, Dr. G.....2647 Washington av.
Stewart, A. K.....Turner Bldg.
Straub, A. W..... .....International Bank.
Smith, Irwin L.....87 Vandeventer pl.
Staudinger, Dr. B... .....1703 Olive st.
Seever, W. J.....1600 Lucas pl.
Simmons, W. D.....Care Simmons Hardware Co.

Terry, Robert J.....2728 Washington av.
Taussig, J. J .....1421 Missouri av.
Tittman, Eugene C.....1811 Kennett pl.
Tivy, W. H..... .....215 N. 2d st.
Timmerman, A. H .....Washington University.
Toensfeldt, J .....912 S. 9th st.
Trelease, Wm.....Missouri Botanical Garden.
Thacher, A.....4109 Washington av.
Turner, T. D.....1004 Garrison av.
Taussig, Dr. Wm.....3447 Lafayette av.
Teichmann, W. C.....1610 Mississippi av.

Updegraf, M.....Columbia, Mo.

Von Schrader, Otto.....2648 Locust st.

Wheeler, C. B.....1515 Lucas av.
Wheeler, H. A.....2700 Pine st.
Watts, M. F.....3542 Chestnut st.
Whitten, Jno. C.....Columbia, Mo., care University of Mo. College of Agriculture.
Whitelaw, O. L.....409 N. 2d st.
Whittier, Chas. T.....St. Louis Medical College.
Wislizenus, Fred.....803 Wainwright Bldg.
Woodward, C. M.....3013 Hawthorne Bldg.
Witt, Thos. D.....E. Jaccard Jewelry Co.
Winslow, A.....Roe Building.
Walsh, Edw. J.....417 Olive st.
Whitaker, Edw.....300 N. 4th st.
Wiener, Prof. Leo.....Columbia, Mo.
Wittenberg, Paul.....2d & Pine sts.
Winkelmeyer, Christoph.....3540 Chestnut st.

Yeatman, James E.....412 Olive st.

PROCEEDINGS OF THE ACADEMY OF SCIENCE OF ST. LOUIS.

JANUARY 4TH, 1892.

President Nipher in the chair, 16 members present. The following officers for the year were elected:—

President.....H. S. Pritchett.
First Vice-President.....M. L. Gray.
Second Vice-President....Robert Moore.
Recording Secretary.....Arthur Thacher.
Corresponding Secretary..Wm. Townsend Porter.
Treasurer.....Enno Sander.
Librarian.....Gustav Hambach.
Curators.....Gustav Hambach, E. A. Engler, Arthur Thacher.
Directors.....J. M. Leete, F. E. Nipher.

The retiring president, Prof. Nipher, made the following address:—

"*Gentlemen of the Academy:*

In turning over to my successor the office with which you have so long honored me, it does not seem fitting that I should enter upon any discussion of the future aims or policy of the Academy. It has always been an easy matter to lay plans for the future. It is easy to see what a rapid development would be possible if we could secure a permanent home, where our valuable library could be made safe against fire, and could be made more accessible to members. This is all possible if the necessary financial aid can be secured. Our former presidents have often indulged in pictures of this kind, but the realization of these hopes is yet in the future. The Academy has one element of great strength. Its charter is much more liberal than could now be secured by a newly organized body, in that it can hold property free of taxation, not only as a charitable institution but by the express terms of its charter.

It remains only for those who have the interests of science at heart to allow no unworthy motives to stand in the way of the financial success of the Academy of Science. Let us have no divided house. The Academy has an honorable history with a goodly perspective of honored names. Its founda-

tion is large enough in outline to afford a place for all who wish to do scientific work in our midst. Its policy has always been, and should be, to offer congenial good-fellowship to men of scientific tastes, however widely their fields of labor may be separated, and to publish whatever may be produced in any field of science which is in any way an advance upon what is known. In working for the advancement of our Academy we must be inspired with the zeal of men who expect success, and we must possess our souls in the patience of those whom disappointments can not discourage. And as we gain strength we must guard our Academy with jealous care against unworthy ambitions, and the discords which they always breed.

There are plenty of examples before us of scientific bodies divided into hostile factions, struggling for the possession of control in a society which has ceased to have any reason for existence.

I do not say these things now because I fear that there is any serious danger of this kind for us at present. The members of this Academy have always understood each other, and have always felt for each other the warmest feelings of confidence and esteem. It is, however, because I wish to add emphasis to these words, that I declined longer to accept the position with which you have so long honored me.

In conclusion, I wish to express to you my grateful appreciation of the uniform courtesy and forbearance with which you have always treated me, and to pledge my constant and loyal support to the Academy. Let us all do our utmost to make the new administration successful in all that it undertakes.

Gentlemen, I now have the honor to declare the following gentlemen duly elected:

OFFICERS FOR 1892.

President.....H. S. Pritchett.
First Vice-President.....M. L. Gray.
Second Vice-President....Robert Moore.
Recording Secretary.....Arthur Thacher.
Corresponding Secretary...W. Townsend Porter.
Treasurer.....Enno Sander.
Librarian.....Gustav Hambach.
Curators.....Gustav Hambach, E. A. Engler, Arthur Thacher.
Directors.....Jas. M. Leete, F. E. Nipher."

At the conclusion of his remarks, Prof. Nipher appointed Messrs. Wheeler and Seddon to escort the newly elected President, Prof. H. S. Pritchett, to the chair.

After accepting the duties and responsibilities of the office in a few appropriate remarks, Prof. Pritchett proceeded to the business of the meeting, and called for annual reports.

The report of the Treasurer was read and approved, as was also the annual report of the Corresponding Secretary. Prof. Nipher presented for publication the paper on "The Rotary Polarization of Light in Hydrocarbon Serial Com-

pounds '' which he read at the last meeting. Referred to the Council.

Dr. Townsend Porter made some remarks on " The Filling of the Heart '' and announced that he would conclude them at the next meeting of the Academy.

January 18th, 1892.

President Pritchett in the chair, 9 members present. Dr. W. Townsend Porter concluded the reading of his paper on " The Filling of the Heart."

Dr. H. Wellington Adams submitted a verbal account of the new method of transmitting power electrically, known as the multiphased alternating current system, as employed in the Frankfort Exposition in the Frankfort-Laufen transmission experiment.

February 1st, 1892.

President Pritchett in the chair, 9 members present. The Council reported the resignation of Dr. G. Hinrichs.

Prof. Pritchett gave a brief statement of the recent photographic studies of star spectra at the Harvard observatory. The point of interest consisted in the discovery of the absorption lines of certain stars, showing a periodic doubling. The explanation of this is to be found in the fact that the stars are really double, consisting of two components revolving about a common center of gravity. At certain parts of this revolution the components would be traveling in opposite directions with respect to the observer, which would account for the doubling of the absorption lines.

February 15th, 1892.

President Pritchett in the chair, fourteen members present. On motion the Academy of Science of Kansas City was placed on the Exchange list.

Prof. Nipher gave the results of a determination of the latent heat of vaporization of water by means of a Bunsen burner and a copper retort. The thermometer used read to tenths of a degree. The thermometer was placed in the water in the retort, the temperature being at first the ordinary temperature of the atmosphere. The flame was turned on, and kept constant by supplying the gas at any desired constant pressure. The thermometer was then read at the end of each minute during the heating to 100 degrees C.; the readings were continued during the evaporation of any weighed amount of water and during the cooling down of the retort with the remaining water. The sources of error were pointed out and it was shown how corrections could be made, but they had proved more troublesome than had been anticipated. He thought the method was one which might be used to advantage in the case of a student who was ambitious to try his powers as an experimenter, but thought it less desirable as a method for accurately determining the latent heat than the one usually employed.

President Pritchett read a paper giving an account of the discovery and spectroscopic and photographic study of the new star in Auriga.

The record of the Harvard photographs showed the star had become visible about December 1st, and had attained at maximum brightness December 20th, when it was of the fourth magnitude. By February 2d, it had sunk to the fifth magnitude.

The spectroscope study showed a type of spectrum very similar to that of the Coronal. The lines were much disturbed and showed evidence of violent internal disturbances.

A discussion of the temporary stars which have been seen in historic times was given. The general conclusion has been reached that these temporary outbursts are due to collisions of meteor streams.

The secretary read a communication from Prof. Trelease concerning a proposed change in the by-laws for the purpose of doing away with the initiation fee.

March 7th, 1892.

President Pritchett in the chair, and about 40 members and 120 visitors present.

On motion the regular order of business was suspended and Prof. Prichett proceeded with the reading of his paper on "The Progress of Astronomy During 1891." The paper contained a complete resumé of the work for 1891, and was fully illustrated by stereopticon views.

March 21st, 1892.

President Pritchett in the chair, 21 members and 4 visitors present. Dr. Porter presented an application from the Alpine Club to be placed on the Exchange list, which was referred to the Council.

Prof. Engler then read a paper on "A Geometrical Construction for Finding the Foci of the Sections of a Cone of Revolution." The paper was referred to the Council for publication.

Prof. Wheeler presented "Some Notes on the Glacial Drift." He noted the occurrence of the till-formation or the blue-clay boulder bearing formation on West Pine street where it occurs for a distance of about 2,000 feet, and a maximum thickness of 12 feet. After commenting on this being the most southerly known extension of the old glacial ice-sheet, he made some remarks on the theories of the "Ice-Age."

Prof. Pritchett gave a brief resumé of the "History of the Sun Spots, Magnetic Storms and Aurorae" during the disturbed period, February 5–17. This consisted chiefly of the results of observations at Greenwich and Potsdam near Berlin. The group of Sun Spots to which the terrestrial disturbances were directly attributed appeared on the East limit of the Sun on February 5th, and passed round the West limit on February 17th. The total spotted area was 1-350 of the Sun's visible hemisphere and is the largest group of spots ever photographed at Greenwich. The magnetic disturbances coincident with enormous changes in these spots began on February 13th

Great changes were observed both in the horizontal and vertical faces. The vibration of the face read to amounts to over 2 degrees declination at Greenwich. At Potsdam vibrations of over 3 degrees were observed. A brilliant aurora was observed at Greenwich on the 14th.

It was moved to defer action on the proposed amendment to the By-laws until the next regular meeting.

April 4th, 1892.

President Pritchett in the chair with 40 members and 120 visitors present.

The regular order of business was dispensed with, and Prof. Nipher gave a lecture on the "Modern Dynamo," which lecture was fully illustrated with stereopticon views and laboratory experiments.

April 18th, 1892.

President Pritchett in the chair, 16 members present. Professor Holden presented to the Academy a photograph of a drawing by Prof. Weinek of the Lunar Crater Petavius.

Dr. Todd gave a description of the dentition of the elephant. The growth of the teeth was fully explained and illustrated with skulls and teeth.

The question of the Amendment to Article 15 of the By-laws was brought up for discussion and an amendment offered so that it would read "Active members shall pay an initiation fee of $5.00 in addition to which resident members shall pay annual dues of $6.00, and non-resident members shall pay dues of $2.00."

This was referred to the Council for their consideration.

Prof. Pritchett reported that the Council looked favorably upon the formation of an Archæological Section.

May 2nd, 1892.

The Academy met at Washington University with President Pritchett in the chair and about 40 members and 80 visitors present.

After calling the meeting to order, President Pritchett announced that the regular order of business would be suspended, and Prof. W. B. Potter then delivered a lecture on "The Progress of Geological Science." The lecture described the methods of investigation from the earliest time to the present day, and was fully illustrated by stereopticon views.

May 9th, 1892.

A special meeting of the Academy was held in the Academy rooms with President Pritchett in the chair, and present also Messrs. Sander, Potter, Chaplin, Smith, Green, Nipher, Stewart, Letterman, Lind and Thacher.

After calling the meeting to order the president announced that the object of the meeting was the consideration of the advisability of forming an Archæological Section. After some discussion it was moved and carried that the president and secretary be appointed a committee to draw up and present to the next meeting an amendment to the constitution permitting the formation of sections to the Academy.

May 16th, 1892.

President Pritchett in the chair, 15 members and 3 visitors present.

The committee appointed at the meeting of May 9th to draw up an amendment to the constitution permitting sections of the Academy presented the following report:—

Article VII. Of Sections.

Section 1. To encourage and promote special investigations in any branch of Science, members of the Academy may form sections, which shall be constituted as herein provided.

Section 2. For the formation of a section, written application shall be made to the Academy, at a regular meeting, by not less than six active members. On the approval of this application by the affirmative votes of two-thirds of the members present at the next regular meeting, the section shall be established, and the names of the petitioners shall be recorded on the minutes as its founders.

Section 3. Sections may increase the number of their members by election, but only members of the Academy shall be elected members of any of the sections.

Section 4. The officers of each section shall be a chairman and a secretary, who shall be elected by its members at the first meeting of the section, and subsequently at the first meeting in January of each year.

Section 5. The collections and books of each section are the common property of the Academy. Donations of books and specimens made to or for any section, shall be received as donations to the Academy for the use of that section.

Section 6. A report of the proceedings of each section shall be submitted to the Academy at least once every month. Papers read before any section with a view to publication by the Academy shall take the same course as papers read before the Academy.

Section 7. On all points not herein provided for, each section shall be governed by the constitution, by-laws and instructions of the Academy.

H. S. Pritchett,
Arthur Thacher,
Committee.

The report was accepted.

Mr. Arthur Winslow read the paper on "The Progress of Mapping in Missouri." The paper covered the explorations and surveys made in the State of Missouri from the earliest times down to the present date, and was fully illustrated with maps and diagrams.

Prof. E. A. Engler submitted for publication a paper on the "Geometrical Constructions for Cutting from a Cone of Revolution Sections (a) of a Given Eccentricity, (b) of Given Latus Rectum."

June 6th, 1892.

President Pritchett in the chair, 30 members and 5 visitors present.

Dr. Jos. Spiegelhalter presented to the Academy the original maps and statistics prepared in 1868 by Col. Robt. J. Rombauer on the Cholera Epidemic of 1866 and 1867.

Dr. Hurter presented to the Academy three volumes of the Auk.

Prof. Nipher presented a communication on Phenomena of Four Phase Currents. He showed the characteristic features of poly-phased currents. The currents were collected from four equidistant points in the armature of a Gramme generator, and were sent into four symmetrical coils on a large ring of wrought iron wire. A glass plate above the ring was sprinkled with iron powder. The iron particles adhered in small masses, which rotated with the traveling pole near the center of the plate. The filings just over the iron ring swept around the plate in an opposite direction from that of the motion of the polarity, due to rotation around horizontal axes converging in the axis of the iron ring. As the pole approaches a heap of iron powder it begins to adhere in filaments which quickly rise and stand vertically when the pole is beneath. As the pole passes on they lie down in an opposite direction. The result is a spinning, heels-over-head tumbling of the particles takes place, and all sweep around in a direction opposite from that of the traveling polarity.

Dr. G. N. Bock presented a paper on "Modes of Burial used by the Ancient Mayas of Guatemala." Dr. Bock's paper was fully illustrated with numerous photographs, pottery and stone images and utensils.

Article 15 of the By-laws was amended so that it would read "Resident active members shall pay an initiation fee of $5.00, and annual dues of $6.00, payable at the beginning of each year. Non-resident active members shall pay an initiation fee of $5.00, and annual dues of one-half the dues for resident active members, payable at the beginning of each year."

Dr. Sander was instructed to invest $1,000.00 of the funds of the Academy.

October 17th, 1892.

President Pritchett in the chair, and thirty members and ten visitors present.

The Corresponding Secretary presented a letter from Mr. Henry B. King, in which he mentioned that he had in his possession a number of survey notes collected by his father,

which had never been published. The letter was referred to the Council.

Prof. Pritchett read some notes by Profs. Holden and Barnard of the Lick Observatory, Hall of the Naval Observatory, Young of the Princeton Observatory and Swift of the Rochester Observatory on "The Physical Observation of Mars During the Opposition of 1892." These papers gave in brief the results of physical studies of the planet during recent favorable opposition. The most interesting deduction from them is the magnitude of the changes going on upon the surface of the planet. It seems scarcely possible that these changes can be completely explained by terrestrial analogies. Thus in one month an area of 1,600,000 square miles of snow had been converted into water. With the extensive oceans we have upon the Earth, this would produce but little effect, but upon Mars, whose total permanent water area amounts to less than one-third of this area, the effect would be vastly greater. Moreover upon the Earth, the semi-annual transfer of melted snow from pole to pole is conducted by means of oceans, but upon Mars this transfer takes place across the land. To this fact might reasonably be attributed many of the changes in the surface.

In the last week of June the northern limit of the south polar cap was in latitude 65 degrees, corresponding in our northern latitude to the northern point of Iceland, somewhat nearer the pole than we would expect to find it on the Earth at the same interval after the Equinox.

The rapidity with which the snow cap has disappeared would seem to indicate further that the depth of the snow deposit on Mars is much less than on the Earth, a result which corresponds with the known rarer atmosphere and presumably lighter precipitation.

The testimony of the large telescopes of North America except in the case of the Lick Observatory can scarcely be said to confirm Schaiparelli's discoveries. In this connection, however, the large southern declination of the planet needs to be taken into account.

The experience of the present year emphasizes the fact that the erection of large telescopes in localities where the atmos-

pheric conditions for observing are poor, promises but little return to science and that the improvement of our knowledge of the physical characteristics of the Stellar Universe is to be found in seeking improved points of observation, such as are most probable to be found on high plateaus.

Mr. Chas. Robertson presented a paper on "Flowers and Insects-Labiatae."

Prof. G. G. Broadhead presented a paper on "The Ozarks and Geological History of Missouri Palaeozoic Formations."

The president was authorized to appoint a committee to consider the question of a change of quarters.

November 7th, 1892.

Vice-President Gray in the chair, twelve members present. The Corresponding Secretary read a letter from Dr. Branner, asking for an exchange of publications, which was referred to the Council.

Dr. Green read a paper on "The Opening of the Buds of Some Woody Plants," by Prof. S. S. Hitchcock.

November 21st, 1892.

President Pritchett in the chair, seven members present. Dr. Sander made a statement concerning the collection of membership fees.

December 5th, 1892.

Prof. Pritchett in the chair, ten members present. The following committee were elected to make nominations of officers for the ensuing year:—

Dr. Green, Chairman.
Judge Speck.
Prof. Potter.

The meeting then adjourned to the lecture room, where Dr. Ludwig Bremer delivered a lecture on "The Evolution of Brain and Civilization." The lecture was illustrated by a number of diagrams, and the development of the brain from protoplasm to man was clearly shown. The meeting was attended by 20 members and 40 visitors.

DECEMBER 19TH, 1892.

President Pritchett in the chair, 20 members and 6 visitors present.

The committee on nominations for officers for 1893 reported the following nominations: —

President .....H. S. Pritchett.
1st Vice-President.....M. L. Gray.
2d Vice-President.....G. Baumgarten.
Recording Secretary.....A. Thacher.
Corresponding Secretary..W. Townsend Porter.
Treasurer.....Enno Sander.
Librarian.....Gustav Hambach.
Curators.....Gustav Hambach, E. A. Engler, Arthur Thacher.
Directors.....Jas. M. Leete, F. E. Nipher.

The Corresponding Secretary read an invitation from the American Philosophical Society to send a delegate to their 150th anniversary meeting. Referred to the Council.

Dr. W. Townsend Porter presented a paper on "A Demonstration of Embryological Methods, Illustrating the Preparation of Serial Sections of Embryo Chicks for the Microscope."

The paper was fully illustrated with specimens and apparatus showing the full method of conducting the operation.

January 3rd, 1892.

A reception was given by Col. Leighton to the members ot the Academy to meet Mr. Mark W. Harrington. Mr. Harrington and about 80 members of the Academy met at Col. Leighton's house and passed a very enjoyable evening.

January 4th, 1895.

The members of the Academy met at the Memorial Hall, and Mr. Mark W. Harrington, Chief of the United States Weather Bureau, gave an interesting lecture on "The Present Status and Future Prospects of Government Weather Bureaus."

January 16th, 1895.

President Pritchett in the chair, 15 members and one visitor present. The report of the Treasurer was received and approved. The Nominating Committee reported the election of officers for 1893 as follows: —

President	H. S. Pritchett.
1st Vice-President	M. L. Gray.
2nd Vice-President	G. Baumgarten.
Recording Secretary	Arthur Thacher.
Corresponding Secretary	W. Townsend Porter.
Treasurer	Dr. Enno Sander.
Curators	G. Hambach, E. A. Engler, A. Thacher.
Librarian	G. Hambach.
Directors	F. E. Nipher, J. M. Leete.

A paper was presented by Mr. J. Christian Bay on "Material for a Monograph on Inuline." Referred to the Council.

February 6th, 1893.

President Pritchett in the chair, ten members present. The Corresponding Secretary read a letter from the president of the National Geographical Society, inviting the Society to appoint a representative to act on the Advisory Committee for the Geographical Conference to be held in Chicago. This was referred to the Council for power to act.

February 20th, 1893.

The Academy met in the lecture rooms at Washington University with 75 members and visitors present.

Dr. C. O. Curtman delivered a lecture on "The Detection and Analysis of Blood." The qualities of blood were described and the morphological and chemical tests for showing the difference between the blood of animals and that of man were explained. It was shown that the human blood could not safely be distinguished from that of the dog or monkey. The lecture was illustrated by a number of lantern slides.

March 6th, 1893.

President Pritchett in the chair, and 14 members and 4 visitors present.

Dr. W. Townsend Porter read a paper on "The Question of a Co-ordinating Center in the Ventricles of the Heart."

Dr. Porter also read a paper on "The Results of Ligation of the Coronary Arteries." The paper gave the result of a series of interesting experiments.

Dr. Porter read a paper on "The Physical Basis of Precocity and Dullness." The paper was based on the examination of over 30,000 of the school children of St. Louis. The results were tabulated and brought out some very interesting facts.

March 20th, 1893.

President Pritchett in the chair, 65 members and 15 visitors present.

Prof. Pritchett introduced Prof. Barnard of the Lick Observatory. Prof. Barnard gave an interesting description of the Lick Observatory at Mt. Hamilton. The lecture was fully illustrated with a large number of beautiful views.

April 3d, 1893.

President Pritchett in the chair, 8 members and 2 visitors present.

Dr. W. T. Porter read a paper on "The Effect of Embolism of the Coronary Arteries on the Closure of the Auricle-Ventricular Valves."

April 17th, 1893.

President Pritchett in the chair, 30 members and 30 visitors present.

Messrs. T. G. Allen, Jr., and W. L. Sachtleben gave an interesting description of their bicycle tour across Asia. A large part of the route was across Russia and Chinese territory, which had never been visited by foreigners.

May 1st, 1893.

President Pritchett in the chair, 22 members and 4 visitors present.

Prof. E. A. Engler reported for the Committee on Permanent Quarters that they had been considering various propositions, and as some of these were still pending it was deemed wise to take no action.

Prof. Trelease exhibited a specimen of wood gathered in the southeastern part of this State last autumn by Mr. B. F. Bush, and stated that the wood was known locally as cork

wood, because of its extreme lightness and that it was obtained from a small tree, which belonged to the genus Leitneria, of which one species has been described from the swamps of Florida, where it becomes a shrub, while one or two references have been made to a similar or identical species collected in scanty specimens in southern Texas and the adjoining part of Mexico.

The specific gravity of our native woods as reported in Prof. Sargent's volume on the forests of the United States, ranges from 0.2616 (Ficus aurea) to 1.302 (Condalia ferrea), both from Florida, — the greater number of species lying between 0.40 and 0.80. One Indian wood has been reported as having a specific gravity of 0.260, but so far as the speaker could learn, no wood of lower specific gravity than this has ever been observed. The cork wood collected by Mr. Bush was so extremely light that at the request of the speaker Prof. Nipher had some time since made a determination of its specific gravity which he found to be 0.207, or almost exactly one-fifth the density of water. According to the statement in Ganot's Physics, cited by Prof. Nipher, the density of cork is given as 0.24, so that this Leitneria wood proves to be not only very much lighter than the lightest wood of which record could be found, but also very much lighter than the commercial cork.

A series of photosicrographs, illustrating the structure of the cork wood were exhibited, showing in the thin walled cells a reason for this low specific gravity, and the speaker called attention to the light thrown by a sicroscopical examination upon the affinities of the plant, making reference to the views of Chapman, Baillon and Benthan and Hooker, and of Van Tieghem and Lecomte, who some years since made a historical study of the wood of the Floridan plant.

Mr. Bush, who was present, was introduced to the Academy, and gave an account of the region in which this Leitneria occurs, making reference to the large number of Floridan species which had been discovered in the southeastern part of Missouri during his collecting trips in the interest of the Botanical Garden and the World's Fair Commission of Missouri.

May 18th, 1893.

President Pritchett in the chair, 350 members and visitors present.

President Pritchett introduced Dr. T. C. Mendenhall, who delivered an illustrated lecture on "The Seals and Their Home." Dr. Mendenhall while acting as Commissioner of the United States to report on the seal islands had had an excellent opportunity to study the habits of the seals and the lecture was exceedingly interesting and valuable.

After the lecture a reception was given in the galleries of the Museum of Fine Arts to meet:—

Dr. T. C. Mendenhall, Supt. U. S. C. & S. Survey.
Dr. Asaph Hall, U. S. N. Observatory.
Dr. R. H. Jesse, President of the University of Missouri.
Dr. Geo. L. Goodale, of Harvard University.
Dr. C. O. Whitman, of the University of Chicago.

May 22nd, 1893.

In pursuance to a call for a special meeting of the Academy President Pritchett in the chair, and 21 members present.

The President stated that the meeting had been called to consider a proposition by the Missouri Historical Society for the two societies to unite in erecting a building and establishing a museum. A committee of three was appointed to confer with the committee from the Missouri Historical Society.

June 5th, 1893.

President Pritchett in the chair, 20 members and 2 visitors present.

Prof. Nipher gave the result of a determination of Johle's equivalent made by students in Washington University. The method was to place a wire wound in a single layer around a tube of glass around which a current of water was circulated

under a constant head. The temperature change due to heating coils was measured to tenths of a degree. The value resulting was 4.20x107.

Prof. Pritchett presented the following report:—

ST. LOUIS, June 5th, 1893.

To the Academy of Science, St. Louis:

Your committee appointed to confer with representatives of the Missouri Historical Society beg to report as follows:—

ST. LOUIS, May 31st, 1893.

A meeting of a number of gentlemen interested in the Academy of Science and the Historical Society was called at Col. Leighton's house, 803 Garrison avenue. Present: Mr. Geo. Leighton, Mr. H. W. Eliot, Mr. C. W. Collet, Dr. Emile Praetorius, Capt. W. S. Boyce, Dr. Enno Sander, Dr. F. L. Haydel, Mr. Robert Moore, Mr. M. L. Gray and Mr. H. S. Pritchett.

The meeting was called to order by Col. Leighton, who requested Mr. Pritchett to act as Secretary. After long discussion of plans for furthering the erection of a proper building for museum and library, the following resolution was adopted:—

"*Resolved*, That this meeting recommend the formation of a stock corporation to be known as the St. Louis Museum Association, to be managed by a board of 11 directors, the purpose of the corporation being the erection of a building for museum purposes, and to provide suitable quarters for the libraries and museums of the Academy of Science of St. Louis and the Missouri Historical Society and kindred societies."

It was further voted that copies of this resolution be forwarded to the Academy of Science and to the Missouri Historical Society.

Respectfully submitted,

H. S. PRITCHETT,
H. W. ELIOT,
ROBERT MOORE,
} Committee.

On motion the report was approved and the Committee continued with power to increase their number and take such steps as would be necessary to carry out the recommendations of the report.

JUNE 19TH, 1893.

President Pritchett in the chair, eight members and one visitor present.

A paper by Prof. L. H. Pammel on "Sclerotina Libertianam with a Bibliography of Fungus Root Diseases" was presented. On motion it was referred to the Council.

President Pritchett presented the following communications from the Missouri Historical Society:—

"At a meeting of the Missouri Historical Society convened specially to consider a circular from H. S. Pritchett, on June 12th, 1893, Bp. Tuttle presiding, the following resolution was adopted, *nem. cont.* as expressing the sense of the meeting on the matters to which the communications related.

Resolved, That the Society views with much gratification the proposal to form a stock corporation to erect a building for museum purposes and provide suitable quarters for itself, the Academy of Science, and kindred societies, and undertakes to use its influence to secure practical co-operation in carrying out such designs.

Provided, That the Society's Archæological Collection may be transferred to the custody of the Academy of Science for public use and two-fifths of the value thereof (said value fixed at $25,000) reimbursed to the Society.

Certified correct.

OSCAR W. COLLET, Secy."

On motion action on the communication was deferred until the first meeting of the Academy in the fall.

Dr. Sander, Treasurer, presented the following communication: —

"JUNE 3, 1893.

DR. ENNO SANDER,

No. 129 S. 11th St., City.

DEAR SIR: —

Enclosed please find Scottish Union and National Policy No. 1690842, written for five years from the 1st inst., for $5,000.00 on property of the Academy of Science, 17th and Washington avenue. You will note that the form of policy is the same as the Boylston Policy No. 81749, excepting the eighty per cent of insurance clause, which is now made a part of all forms, and we would, therefore, suggest your insuring this property as near eighty per cent of its value as you can estimate, for in case of a partial loss we would settle on the basis of eighty per cent of insurance to value. This

would only apply in case of partial loss, as in event of the total destruction of the property, we would pay the face of the policy, if the value amounted to as much as the insurance.

Trusting same will be found in order,

Yours truly,

F. D. HIRSCHBERG & BRO."

Enclosure.

Dr. Sander said that insurance to the amount of $10,000 was now carried by the Academy on its property at 17th and Washington avenue. On motion the Treasurer was directed to answer the communication and to say that the $10,000 now carried covers eighty per cent of the cash value of the property insured.

OCTOBER 16TH, 1893.

Prof. Pritchett in the chair, twenty-eight members and two visitors present.

Prof. Pritchett presented for Dr. Holden, Director of the Lick Observatory, some positives from the original negatives taken on the occasion of the total eclipse of the sun in April last, at a point in Chile. Accompanying the negatives was a brief statement of the study of them, made by Prof. Schaeberle, in which he calls attention to the permanence of well defined lines, as shown in the photographs.

Prof. Pritchett presented a proposition from the Missouri Historical Society for the purchase of their Archaeological Collection.

On motion the President was instructed to appoint a Committee of five to consider this proposition. The President appointed the following Committee: M. S. Snow, H. W. Eliot, F. E. Nipher, Jno. Green, A. W. Douglas.

NOVEMBER 6TH, 1893.

President Pritchett in the Chair, twenty-one members and two visitors present.

Mr. Julius Hurter presented an interesting paper on the "Reptiles and Amphibians of Missouri."

Dr. W. Townsend Porter presented a valuable paper on the "Relation Between the Growth of Children and Their Deviation from the Physical Type of their Age and Sex."

November 20th, 1893.

President Pritchett in the chair, ten members and one visitor present.

Prof. Kinealy gave a graphical method for finding the velocity of the piston in a steam engine. He made use of a curve which very much resembled the lemniscate, giving its equation, and some of its properties. He showed how its use very much simplified the computation of the velocity of the piston.

Dr. Wm. Townsend Porter showed a modification of the ordinary apparatus in use for registering blood pressures. His modification was the substitution of a rubber bulb for the cumbrous water-box ordinarily used, to make the required changes of pressure.

December 4th, 1893.

President Pritchett in the chair, 15 members and 1 visitor present.

Dr. Hambach described some new fossils of Missouri.

Prof. Trelease, Judge Speck and Prof. Snow were elected a Committee to nominate officers for the ensuing year.

The president referred to the death of Mr. Louis Schoelch, and the lecture of Prof. Morehead for Dec. 19th was announced.

December 18th, 1893.

President Pritchett in the chair, 15 members present. The Committee on Nominations reported the following nominations for 1894: —

President .....H. S. Pritchett.
1st Vice-President.....M. L. Gray.
2d Vice-President.....G. Baumgarten.
Recording Secretary.....A. W. Douglas.
Corresponding Secretary..A. S. Cushman.
Treasurer .....Enno Sander.
Librarian .....G. Hambach.
Curators .....G. Hambach, A. Thacher, Jno. Green.
Directors .....F. E. Nipher, J. M. Leete, Dr. Jno. Green.

The Committee appointed in October to consider the purchase of Archaeological Collection of the Historical Society reported that the proposition had been withdrawn.

A committee was appointed to consider a proposition from the Historical Society for renting quarters in their building, and report to the Academy at a special meeting to be called for that purpose.

ARTHUR THACHER,
Recording Secretary.

JANUARY 15TH, 1894.

President Pritchett in the chair and 10 members present. The Committee on Nominations made the following report, showing the names of the officers elected for 1894:—

President .....H. S. Pritchett.
1st Vice-President.....M. L. Gray.
2d Vice-President.....G. Baumgarten.
Recording Secretary.....A. W. Douglas.
Corresponding Secretary..A. S. Cushman.
Treasurer .....Enno Sander.
Librarian .....Gustav Hambach.
Curators .....Gustav Hambach, Arthur Thacher, Jno. Green.
Directors.....Jno. Green, F. E. Nipher.

A report of the Committee investigating the question of moving to the Missouri Historical Rooms was read.

A paper was presented by Dr. Glatfelter on Selix Nigra and S. Amygdaloids.

The reports of the Librarian, the Corresponding Secretary and the Treasurer were read and approved.

February 5th, 1894.

President Pritchett in the chair, 25 members and 10 visitors present.

The President made a brief address, congratulating the Academy on their removal to their new quarters, and read an extract from the minutes of the Academy some twenty years ago, showing that it was at that time the desire of the Academy to occupy the same quarters with the Missouri Historical Society, so that the Academy could still further be congratulated in having attained its object after patient waiting.

Prince Kooloovoomah, of Sierra Leone, spoke in a most interesting manner of the customs and folk-lore of his people. Accompanying his lecture was a song and several quotations in his native tongue.

A notice was read of an amendment offered by President Pritchett to Article V., Section 1, the intent of which was to add the Treasurer to the members of the Council.

February 19th, 1894.

President Pritchett in the chair, 30 members and 5 visitors present.

Prof. Hicks, of the University of Missouri, read an address on Economics, reviewing briefly the past history of our country on this subject, speaking of the present problems, mentioning the evils of majority rule, and of the plan of electing United States Senators by popular votes. He referred to the industrial questions of the day as embodied in matters of finance and banking, our distributive system, the relations of

the State and the individual, the tariff, and the revenue, the labor question and the reciprocal duties of man and society. Prof. Hicks urged the formation of a social science section of the Academy of St. Louis.

Prof. Hicks' paper was discussed by several members, and the President was authorized to appoint a committee of five to investigate and report to the Academy, the advisability of organizing a section of the Academy for the scientific study of Economics.

MARCH 6TH, 1894.

President Pritchett in the chair, and 15 members present. The President introduced Dr. Armand N. Ravold, who then presented a paper "On the Typhoid Bacillus found in the Mississippi River Water." Dr. Ravold prefaced his paper with a brief lecture. He described the modern microscope, and the present classification of micro-organisms and bacteria. The lecturer then described the method of incubating, plating out and separating pure cultures of bacteria. In the very excellent and interesting paper which followed, Dr. Ravold related his experience, in the finding in the Mississippi water of a certain bacillus, which he called Number 21, and which after long and careful work he has succeeded in almost conclusively identifying as the well-known Bacillus Typhesis. The lecture concluded with some excellent stereopticon views of micro-photographs made by Dr. Ravold. A discussion followed, the lecturer called attention to the great need in St. Louis of an isolation hospital where malignant diseases due to pathogenic germs could be treated.

Prof. Nipher moved that a committee be appointed by the President to investigate the matter of the meteorological work heretofore carried on in Forest Park, and see if it could not be carried on under the direction of the Academy.

MARCH 19TH, 1894.

The Academy met at the Memorial Hall at 8 p. m., and listened to a public lecture by Prof. Jno. Pickard of the

University of Missouri on the subject "Greece Through the Spectacles of an Archaeologist."

Upon the conclusion of the lecture the meeting adjourned to the rooms of the Academy, No. 1600 Lucas Place, where an informal reception was given Prof. Pickard, and the rooms of the Academy were thrown open for inspection of members and visitors, and by the kindness of the Missouri Historical Society, its museum was also lighted up for the inspection of members. About 300 members and visitors were present.

April 2nd, 1894.

President Pritchett in the chair, and 15 members and 2 visitors president.

The President called attention to an old volume now in the possession of the Academy which contained the original records of the Academy from its foundation to 1870, and which for some years had been lost. He recommended that the records be placed in a fire-proof safe.

Mr. Jas. Seddon presented a paper on "An Analysis of the Theories of Money."

April 16th, 1894.

President Pritchett in the chair, 23 members and 6 visitors present.

Dr. Edw. C. Runge read a paper on "A Case of Rumination, with the Results of an Investigation of its Digestive Chemism."

The President announced the death of Mr. Jno. T. Davis.

May 7th, 1894.

President Pritchett in the chair, 48 members and 2 visitors present.

Dr. T. J. J. See of the University of Chicago, read a paper

on "Results of Recent Researches on the Formation of the Heavenly Bodies."

MAY 22ND, 1894.

President Pritchett in the chair, 19 members present.

The report of the Committee appointed to consider the advisability of adding to the Academy a section for investigations in Political Science was read, stating that after mature deliberation the Committee concluded that the present was not an opportune time for such action.

A. S. Cushman read a paper on "Post-Mortem Estimation and Detection of Strychnine."

JUNE 4TH, 1894.

Judge Gray presiding, 18 members and visitors present.

Prof. Nipher made a report for the Committee appointed to see if the meteorological work being conducted at Forest Park could be done under the Academy's supervision. He stated that he had been unable to get any satisfaction from the City authorities, and could report no definite action.

The resignation of Pres. Pritchett was read, same being caused by his departure for Europe, and action deferred until the first meeting of the Academy in October.

The introduction to the paper of Dr. R. Ellsworth Call on "The Unionidae of Arkansas" was read by Mr. Whitten.

The Recording Secretary announced the vote by letter ballot, of the amendment to the Constitution, adding the Treasurer to the Council.

Mr. Arthur Winslow laid before the Academy two maps, showing the work of the Geological Survey of Missouri.

A. W. DOUGLAS,
Recording Secretary.

Transactions of The Academy of Science of St. Louis.

VOL. VI. No. 1.

APPENDIX TO THE CATALOGUE OF THE FLORA OF NEBRASKA.

H. J. WEBBER.

Issued March 12, 1892.

No. 9.

APPENDIX TO THE

CATALOGUE OF THE FLORA OF NEBRASKA.

By H. J. Webber.

(Presented October 18th, 1891.)

Considerable material and information having accumulated since the publication of my Catalogue of the Flora of Nebraska, in the Annual Report of the Nebraska State Board of Agriculture for 1889, it is thought best to bring this together as an appendix to the Catalogue.

In the printing of the "separates" of the Catalogue, for some unaccountable reason, the type of the first eighty pages was reset without proof-reading, thus leading to many typographical errors in the "separates" that do not occur in the original as printed in the body of the Report. I have thought best to add a list of such corrections as I have noted, reference being in every case to the "separates."

In the main Catalogue some species not seen by me or by collectors aiding in the preparation of the Catalogue, were reported on the authority of Gray's and Coulter's Manuals, etc. Many of these having since been collected, a list is given with a few distribution notes, under the heading, — *Notes on species before reported.*

I have also included in this list a few corrections that it has been found necessary to make in the identification of species before reported.

In the appendix proper the plan of arrangement followed in the Catalogue has been carried out. The names of those reporting species follow in every case the name of the species reported as it occurs in the appendix. The collector whose name follows the species, it must be understood, is to be taken as the authority for its occurrence, as in many cases I have not had the opportunity to examine the specimens. Thus specimens here reported must be understood to be preserved in the herbaria of those reporting the species or in the Herbarium of the University of Nebraska.

All species reported up to date, on good authority, have so far as

known been included. Prof. C. E. Bessey, Mr. P. A. Rydberg and Mr. T. A. Williams, have collected extensively since the issue of the Catalogue and have kindly furnished me annotated lists of the species they have discovered which were not before reported. I cannot thank them too much for their tedious, painstaking labor.

Prof. G. D. Swezey, of Doane College, Crete, Nebraska, has issued a list of "Nebraska Localities for Flowering Plants in the Herbarium of Doane College," which includes a number of species not reported in my Catalogue. Prof. Swezey kindly sent me specimens of most of the additions for examination. My notes (where desirable) on those examined will be found in the text of this appendix. I have to thank Prof. Swezey for this and several other favors rendered.

Mr. R. N. Pound, Mr. A. F. Woods and several others reporting interesting discoveries, have been duly credited in the text.

For aid in the identification of species reported on my authority in this appendix, thanks are due to Drs. N. L. Britton, C. F. Millspaugh, Geo. Rex, Wm. Trelease and Sereno Watson; Professor L. H. Bailey, Mrs. Elizabeth Britton, Mr. Henry Willey, Mr. M. S. Bebb, Mr. F. V. Coville and Mr. A. S. Hitchcock.

Lastly I am pleased to acknowledge the general aid and support of Dr. Wm. Trelease and Dr. C. E. Bessey throughout the preparation of the paper.

This appendix contains 432 species not before reported; of which 9 are Protophytes, 20 Zygophytes, 7 Oophytes, 117 Carpophytes, 13 Bryophytes, 2 Pteridophytes, and 264 Anthophytes.

The Catalogue contained 1890 species and varieties, of which 39 were Protophytes, 95 Zygophytes, 20 Oophytes, 691 Carpophytes, 47 Bryophytes, 17 Pteridophytes, and 981 Anthophytes.

Thus the Nebraska Flora as at present known contains 2322 species and varieties, of which 48 are Protophytes, 115 Zygophytes, 27 Oophytes, 808 Carpophytes, 60 Bryophytes, 19 Pteridophytes, and 1245 Anthophytes.

In conclusion I wish again to thank those who have so kindly aided me, and to express my gratification that the people of the State of Nebraska are showing increased interest in their not uninteresting flora.

CORRECTIONS.

(g. = genus; s. = species; l. = line.)

Page 37, l. 36, for *faetidissima* read *foetidissima.*
" 38, l. 28, for *when* read *where.*
" 39, l. 13, for *at* read *as.*
" 41, l. 22, *Barns* read *Barnes.*
" 41, l. 29, omit *other.*
" 41, l. 41, omit *many.*
" 42, s. 5, for *flavo-fuscom* read *flavo-fuscum.*
" 44, s. 29, for *marino* read *marina.*
" 44, l. 6, for *diseasees* read *diseases.*
" 51, s. 165, l.9, *Aster ericoides* should be *Aster paniculatus.*
" 54, s. 204, " " " " " "
" 62, s. 364, l. 1, for *salicini* read *salicina.*
" 67, s. 405, l. 32, for *cyndrical* read *cylindrical.*
" 69, s. 418, The host *Aster ericoides* should be *A. paniculatus.*
" 71, s. 437, l. 2, for *canadense* read *canadensis.*
" 71, s. 450, for *Ænothera* read *Œnothera.*
" 74, s. 477, for *Dittm.* read *Ditm.*
" 76, The remark under sterile forms should be — Supposed to be stages of *Ascomycetes* and *Basidiomycetes.*
" 82, g. 205, for *Pericularia* read *Piricularia.*
" 83, s. 640, for *Sporodesmium* read *Sporidesmium.* (As given by De Thuemen. Saccardo evidently unintentionally changes it to *Sporodesmium.*) Also line 5, *scirpiola* read *scirpicola.*
" 87, Order 56, for *Lycoperdiaceæ* read *Lycoperdaceæ.*
" 99, s. 952, for *aristulatus* read *aristatus.*
" 99, s. 956, for *schweinitizii* read *schweinitzii.*
" 122, s. 1342, for *lanceolatus* read *lanceolata.*
" 124, s. 1383, for *stolonifer* read *stolonifera.*
" 126, s. 1404, for *sinnate* read *sinuate.*
" 142, s. 1705, for *rush* read *bush.*
" 149, s. 1853, for *scrotina* read *serotina.*
" 149, s. 1867, for *eupatoriodes* read *eupatorioides.*

NOTES ON SPECIES BEFORE REPORTED.

(The number preceding each, is the species number in the main Catalogue.)

151. CYSTOPUS TRAGOPOGONIS (Pers.) Schroet. On Wild worm-wood (*Artemesia canadensis*), Pine Ridge, Aug., 6 (Webber).

414. GYMNOSPORANGIUM MACROPUS L. Stage II (*Ræstelia pirata Thaxter.*) On leaves of Crab Apple (*Pirus coronaria*) Butler Co., and Lincoln (Bessey).

416. PHRAGMIDIUM SPECIOSUM Fr. The specimens referred to Stage II of this species should be Stage I of *Phragmidium subcorticium* (Schrank) Wint. (See No. 81 of this paper).

520. ASCOCHYTA SMILACIS Ell & Ev. should be of Ell. & Mart. or following Saccardo the nomenclature should be changed to *Stegonospora smilacis* (Ell. & Mart.) Sacc.

622. RAMULARIA VIRGAUREÆ Thuem. On *Solidago canadensis* only, not on *S. rigida* and *S. memoralis*.

709. PODOSPORIUM RIGIDUM Schw. On grape stems only, not on *Physalis*.

886. WOODSIA OREGANA Eaton (Localities omitted in Cat.) Collected at Pine Ridge; Hat Creek Basin; Dismal River, Thomas Co. (Webber).

924. CAREX GRISEA Wahl. (Reported from Coulter's Manual). Ashland, May. (Williams).

926. CAREX JAMESII Torr. var. NEBRASKENSIS (Dew.) Bailey (Reported from Coulter's Manual). Hat Creek Basin, Sioux Co., Aug.; Broken Bow, July; Anselmo, July. (Webber).

929. CAREX LONGIROSTRIS Torr. (Reported from Gray's Manual). Dismal River, Thomas Co., July 12. (Webber). Ashland, Weeping Water, War Bonnet. (Williams).

1088. JUNCUS FILIFORMIS L. (Reported from Gray's Manual). Lawrence Fork Bottoms, Banner County (Rydberg).

1103. NOTHOSCORDUM STRIATUM (Jacq.) Kunth. (Reported from Coulter's Manual). Crete, rare (Swezey).

1126. QUERCUS NIGRA L. (Reported from Gray's Manual). Pawnee Co. (Bessey).

1187. ERIOGONUM ALATUM MICHX. (Reported from Coulter's Manual). Hills. Deuel Co. and Banner Co. (Rydberg).

1197. ATRIPLEX NUTTALLII Watson, is the prevailing *Atriplex* of N. W. Nebraska in the "Bad lands," etc., but is quite rare in the eastern part of the state where *A. patula* var *hastata* is the common form. (Webber).

1202. AMARANTUS CHLOROSTACHYS Willd. of Swezey's Nebr. Fl. Plants p. 13 is likely *Acnida tuberculata* Moq. (Webber).

1213. ARENARIA PUNGENS Nutt. must probably be considered as A. hookeri Nutt. See this appendix No. 269. (Webber.)

1257. NELUMBO LUTEA (Willd.) Pers. (Reported from Gray's Manual). Lakes, etc., plentiful. Fremont, July. (Williams & Bessey).

1302. ELATINE TRIANDRA Schkuhr (Reported from Coulter's Manual). Exeter, Sept. communicated by Dr. Wibbe (Bessey).

1398. MENTZELIA LEVICAULIS Torr. & Gr. should be changed to *Mentzelia nuda* (Pursh.) Torr. & Gr. It is the common Mentzelia of Nebraska. Mr. Rydberg adds the following note in regard to his specimens collected in Deuel and Banner counties: — "They agree in

every respect with Torrey & Gray's description of *M. nuda* except that they have a bracteate calyx. In Porter and Coulter's Fl. Col. *M. nuda* is described as having a bracteate calyx." (Webber).

1491. ASTRAGALUS FLEXUOSUS Dougl. (Reported from Coulter's Manual). Lewellen, Common (Swezey).

1497. ASTRAGALUS MICROLOBUS Gray (Reported from Coulter's Manual). Cultivated ground. Deuel Co., June 25; Cheyenne Co., Aug. 13 (Rydberg).

1498. ASTRAGALUS MISSOURIENSIS Nutt. (Reported from Coulter's Manual). Curtis, Frontier Co., June 22; North of Kimball, Aug. 16 (Rydberg). War Bonnet Canon, June (Williams).

1501. ASTRAGALUS PECTINATUS Dougl. (Reported from Coulter's Manual). Prairies, near Gering July 20 and Pleasant Valley, Scotts Bluff Co., July 28 (Rydberg).

1504. ASTRAGALUS RACEMOSUS Pursh. (Reported from Coulter's Manual). Hills, Curtis, Frontier Co., June 22 (Rydberg).

1559. GILIA IBERIDIFOLIA Benth. (Reported from Coulter's Manual). Cliffs and Canons of Banner and Scott's Bluff Counties, July (Rydberg).

MERTENSIA LANCEOLATA (Pursh) DC. Swezey's Nebr. Fl. Plants, p. 11, should be *Pentstemon cæruleus* number 1612 of the catalogue.

1580. ECHINOSPERMUM REDOWSKII (Hornem.) Lehm. is the var. *occidentale* Watson. Since collected at Dismal River, Thomas Co., July 13; Pine Ridge, July 21 (Webber).

1581. ECHINOSPERMUM REDOWSKII (Hornem.) Lehm. var. CUPULATUM Gray (Reported from Coulter's Manual). Alliance, Aug. 6 (Webber). Chadron (Bates). Venango, Perkins Co., June 23 (Rydberg).

1589. PHYSALIS LANCEOLATA Michx. var. LEVIGATA Gray. (Reported from Coulter's Manual). Old fields, etc. Weeping Water, July (Williams).

PENTSTEMON GLABER Pursh var. UTAHENSIS Watson. Swezey's Nebr. Flowering Plants p. 12, should be *P. haydeni* Watson (see this appendix No. 364) (Webber).

1611. PENTSTEMON ALBIDUS Nutt. (Reported from Gray's Manual). Antelope Co., Aug.; Anselmo, July; Thedford, July; Hat Creek Basin, Aug. (Webber).

1666. GENTIANA CALYCOSA Griseb. All of my Nebraska material of this species should be labeled *G. puberula* Michx. (Webber).

1738. CNICUS PITCHERI Torr. should be *C. undulatus* (Nutt.) Gray. var. *canescens* (Nutt.) Gray. (See this appendix No. 391.) (Webber).

1792. HELIANTHUS PETIOLARIS Nutt. var. CANESCENS Gray. (Reported from Gray's Syn. Flora). Lawrence Fork Bottoms, Banner county (Rydberg).

1804. FRANSERIA DISCOLOR Nutt. (Reported from Coulter's Manual). Prairies, Kearney County; Dix, Kimball Co., Aug. 14 (Rydberg).

ERIGERON GLABELLUS Nutt. of Swezey's Nebr. Fl. Pl. p. 9 should be *E. macranthus* Nutt. (See this appendix No. 411)

1836. ASTER TANACETIFOLIUS (Nees) H. B. K. (Reported from Coulter's Manual). Banner Co., etc. Common in the western part of the State (Rydberg).

1867. KUHNIA EUPATORIOIDES L. var. CORYMBULOSA Torr. and Gr. (Reported from Coulter's Manual). Canons, Banner Co. (Rydberg).

The following tabulated list of new localities for Flowering Plants before reported was prepared by Mr. Rydberg from his collections. Some species are greatly extended in range, and some shown to be much more common than was supposed.

| BANNER CO. | | | | | | | | DEUEL CO. | | | | | | KEARNEY CO. | | | | | | | |

PROTOPHYTA.

1. RETICULARIACEÆ.

1. RETICULARIA Bull.

1. R. LYCOPERDON Bull. On decaying trunks of trees. Pine Ridge, Dawes Co., July (Webber).

2. CLATHROPTYCHIACEÆ.

2. ENTERIDIUM Ehr.

2. E. ROZEANUM (Rost.) Wingate. (*Reticularia* [?] *rozeana* Rost.). Lincoln (Webber).

3. STEMONITACEÆ.

3. STEMONITIS Gled.

3. S. WEBBERI Rex. (N. sp. in lit. Published in Pro. Acad. Nat. Sci. of Phila., 1891). On old stump, Lincoln, September (Webber).

4. PHYSARACEÆ.

4. PHYSARUM Pers.

4. P. LIVIDUM Rost. (*Spumaria licheniformis* Schw.) On bark of tree, Lincoln (Webber).

5. P. PETERSII B. and C. On bark of old Cottonwood and Boxelder trees, Weeping Water (Williams).

5. BACTERIACEÆ.

5. BACILLUS Cohn.

6. B. SORGHI Burrill. On leaves and culms of Bushy blue stem (*Andropogon nutans*), Lincoln; Johnson grass (*Andropogon sorghum* var. *halepensis*), Howard Co.; and on numerous varieties of *Sorghum* grown on the Nebraska Experimental Farm at Lincoln. Quite destructive, forming large irregular purple patches (Webber).

6. NOSTOCACEÆ.

6. GLŒOTRICHIA Ag.

7. G. NATANS Thur. Floating in stagnant water. Greenwood, July (Williams). Minden, attached to *Nitella* stems (Bessey).

7. LYNGBYA Ag. and Thur.

8. L. CINCINNATA Kg. Minden. In material collected by Dr. Hapeman (Bessey).

8. CYLINDROSPERMUM Kg.

9. C. COMATUM Wood. Minden (Hapeman).

ZYGOPHYTA:

7. PALMELLACEÆ.

9. **TETRASPORA Ag.**

10. T. EXPLANATA (Kg.) Kirch. Minden. In material collected by Dr. Hapeman (Bessey).

10. **SORASTRUM Kg.**

11. S. SPINULOSUM Kg. Minden. In material collected by Dr. Hapeman (Woods).

11. **HYDRODICTYON Roth.**

12. H. UTRICULATUM Roth. Stagnant water, plentiful. Fremont, July 31 (Williams). Lincoln (Bessey).

12. **PEDIASTRUM Meyen.**

13. P. ANGULOSUM (Ehrb.) Menegh. (*P. biradiatum* Meyen). In material collected by Dr. Hapeman at Minden. (Woods).

14. P. PERTUSUM Kg. var. CLATHRATUM A. Br. (*P. duplex* Meyen). Minden. In material collected by Dr. Hapeman (Woods).

8. PITHOPHORACEÆ.

13. **PITHOPHORA Wittr.**

15. P. AFFINIS Nordst. In stagnant or slow running water. Greenwood, July (Williams).

9. ULOTHRICHACEÆ.

14. **STIGEOCLONIUM Kg.**

16. S. FASTIGIATUM Kg. Minden. In material collected by Dr. Hapeman (Bessey).

15. **APHANOCHÆTE A. Br.**

17. A. GLOBOSA (Nord.) Wolle. form. MINOR Nordst. growing on *Nitella*, in material from Minden collected by Dr. Hapeman. (Woods).

10. DESMIDIACEÆ.

16. **DESMIDIUM Ag.**

18. D. SWARTZII Ag. Minden. In material collected by Dr. Hapeman (Bessey).

17. **SPHÆROZOSMA Corda.**

19. P. SERRATUM Bailey. Minden. In material collected by Dr. Hapeman (Bessey).

18. **SPIROTÆNIA Breb.**

20. S. CONDENSATA Breb. In material from Minden, collected by Dr. Hapeman.

19. COSMARIUM Corda.

21. C. BROOMEI Thwaites. In material from Minden, collected by Dr. Hapeman Oct. 19 (Woods).

20. XANTHIDIUM Ehrb.

22. X. FASCICULATUM (Ehrb.) Ralfs. In material from Minden, collected by Dr. Hapeman (Woods).

21. ARTHRODESMUS Ehrb.

23. A. OCTOCORNIS Ehrb. In material from Minden, collected by Dr. Hapeman (Woods).

22. EUASTRUM Ehrb.

24. E. INERME Lund. In material from Minden, collected by Dr. Hapeman (Woods).

23. MICRASTERIAS Ag.

25. M. AMERICANA (Ehrb.) Kg. Minden, in material collected by Dr. Hapeman (Woods).

26. M. SPECIOSA Wolle. Minden. In material collected by Dr. Hapeman (Woods).

24. STAURASTRUM Meyen.

27. S. ARISTIFERUM Ralfs. Minden. In material collected by Dr. Hapeman (Woods).

11. DIATOMACEÆ.

25. GOMPHONEMA.

28. G. ACUMINATUM Ehrb. var. LATICEPS Ehrb. Minden. In material collected by Dr. Hapeman. (Bessey).

12. ENTOMOPHTHORACEÆ.

26. EMPUSA Cohn.

29. E. APHIDIS Hoffman. On *Aphis* Sp. on *Polygonum*. Ashland. Oct. (Williams).

OOPHYTA.

13. ŒDOGONIACEÆ.

27. ŒDOGONIUM Lk.

30. Œ. BORISIANUM (Le Cl.) Wittr. In material from Minden collected by Dr. Hapeman (Woods).

31. (E. DELICATUM Kg. Minden. In material collected by Dr. Hapeman (Bessey).

28. BULBOCHÆTE Ag.

32. B. POLYANDRA. Cleve. Minden. In material collected by Dr. Hapeman (Bessey).

14. PERONOSPORACEÆ.

29. PERONOSPORA Corda.

33. P. OXYBAPHI Ell. & Kell On leaves and young shoots of *Oxybaphus nyctagineus*, causing much damage to the host. Elmwood, Ashland. June and July (Williams).

30. PLASMOPARA Schroet.

34. P. HALSTEDII (Farlow) Berl. and De Toni. On leaves of Sunflower (*Helianthus annuus*), Lincoln, Oct. (Webber). Great ragweed (*Ambrosia trifida*), Wabash, Aug. (Williams).

31. SCLEROSPORA Schroet.

35. S. GRAMINICOLA (Sacc.) Schroet. (*Peronospora graminicola* Sacc.) On Green and Yellow fox-tail (*Setaria viridis* and *S. glauca*), Ashland, Weeping Water (Williams). Lincoln (Bessey).

32. CYSTOPUS Lev.

36. C. IPOMOEÆ-PANDURANÆ—Sacc.—Farlow. On leaves and petioles of Morning Glory (*Ipomœa* Sp.) Richardson Co., Aug. (Webber); Ashland (Williams). Very destructive, variously twisting and distorting the leaves and petioles, finally causing them to drop off.

CARPOPHYTA.

15. COLEOCHAETACEÆ.

33. COLEOCHAETE Breb.

37. C. IRREGULARIS Pringsh. Minden. In material collected by Dr. Hapeman (Bessey).

38. C. ORBICULARIS Pringsh. Minden. In material collected by Dr. Hapeman (Bessey).

16. ERYSIPHEÆ.

34. ERYSIPHE Hedw.

39. E. GRAMINIS DC. Conidia stage (*Oidium monilioides* Link.) On leaves of Wild Rye (*Elymus canadensis*), Weeping Water (Williams).

The Oidium is the only stage frequently found here. I have frequently observed this at Lincoln on various grasses, but have never found the perithecia (Webber).

17. SPHÆRIACEÆ.

35. CHÆTOMIUM Kunze.

40. C. CHARTARUM Ehrenb. On decaying broom. Lincoln (Pound).

36. PHYSALOSPORA Niessl.

41. P. MEGASTOMA (Peck) Sacc. On leaves of *Astragalus drummondii*. Belmont, Dawes Co., July. Quite destructive (Webber).

37. SPHÆRELLA Ces. & DeNot.

42. S. OPUNTIÆ Ell. & Ev. On Cactus (*Opuntia missouriensis*), Weeping Water (Williams).

18. HYPOCREACEÆ.

38. NECTRIELLA Sacc.

43. N. VULPINA (Cke.) Berl. & Vogl. On old decaying log, Lincoln (Webber).

19. DOTHIDIACEÆ.

39. PHYLLACHORA Nitschke.

44. P. LESPEDEZÆ (Schw.) Sacc. On Bush clover (*Lespedeza frutescens*), Nemaha Co., Oct. (Webber).

40. PLOWRIGHTIA Sacc.

45. P. RIBESIA (Pers.) Sacc. On stems of gooseberry (*Ribes gracile*), Ashland (Williams).

20. HYSTERIACEÆ.

41. HYSTEROGRAPHIUM Corda.

46. H. FRAXINI (Pers.) DeNot. On Ash (*Fraxinus viridis*) Lincoln (Pound).

21. CALICIACEÆ.

42. ACOLIUM Ach.

47. A. TIGILLARE Ach. On Sandstone, rare. Pine Ridge, Aug. (Webber).

22. GRAPHIDIACEÆ.

43. ARTHONIA (Ach.) Nyl.

48. A. RADIATA (Pers.) Th. Fr. On Hickory bark. Milford, Oct. (Webber).

44. OPEGRAPHA (Humb.) Ach. Nyl.

49. O. VARIA Pers. var. PULICARIS. Bark of trees. Weeping Water (Williams).

23. LECIDEACEÆ.

45. BUELLIA De Not., Tuckerm.

50. B. EPIGÆA (Pers.) Tuckerm. On high sandy ground. Pine Ridge, Aug. (Webber).

46. LECIDEA (Ach., Fr.) Tuckerm.

51. L. TESSELLATA Floerk. On stone. Pine Ridge, Aug. Common. (Webber).

47. BIATORA, Fr.

52. B. MUSCORUM (Sw.) Tuckerm. On moss. Pine Ridge, Aug. (Webber).

53. B. RUSSULA (Ach.) Mont. f. DEALBATA Tuckerm. On earth etc. Valentine, Harrison (Williams).

48. CLADONIA Hoffm.

54. C. BOTRYTIS (Hag.) Hoffm. Rotten Pine log. War Bonnet canon, N. W. Nebraska. (Williams).

55. C. CARIOSA (Ach.) Spreng. On ground under trees on bluffs and in damp places, very common. Pine Ridge, Aug.; Dismal River, Thomas Co., July (Webber); War Bonnet canon (Williams).

24. PARMELIACEÆ.

49. URCEOLARIA Ach.

56. U. SCRUPOSA (L.) Nyl. On sandy ground and sandstone, common. Pine Ridge, July (Webber).

50. LECANORA Ach. Tuckerm.

57. L. BRUNONIS Tuckerm. On sandstone, Ashland. (Williams).

58. L. GLAUCOCARPA (Wahl.) Ach. On stone, common. Pine Ridge, Aug. (Webber).

59. L. PRIVIGNA (Ach.) Nyl. On stone. Pine Ridge, Aug. (Webber).

60. L. SCHLEICHERI (Ach.) Nyl. On ground, abundant. Pine Ridge, Aug. (Webber).

61. L. VARIA (Ehrh.) Nyl. var. SÆPINCOLA Fr. On bark of pine, common. Pine Ridge, Aug. (Webber). On trees, Ashland. (Williams).

51. PLACODIUM (DC.) Naeg. & Hepp.

62. P. ELEGANS (Link.) D C. On stone. Pine Ridge, Aug. A very pretty orange red species, abundant in this region. (Webber).

63. P. MICROPHYLLINUM Tuckerm. On old bark, Pine Ridge, Aug. (Webber).

64. P. VITELLINUM (Ehrh.) Naeg. & Hepp. On sandstone. Lincoln, Sept. (Webber).

52. COLLEMA Hoffm., Fr.

65. C. PULPOSUM (Bernh.) Nyl. On sandstone. Pine Ridge, Aug. (Webber).

53. PELTIGERA (Willd., Hoffm.) Fée.

66. P. HORIZONTALIS (L.) Hoffm. On ground. Pine Ridge, Aug. (Webber.)

54. PHYSCIA (DC., Fr.) Th. Fr.

67. P. HISPIDA (Schreb., Fr.) Tuckerm. On stone. Pine Ridge, Aug. (Webber).

55. PARMELIA (Ach.) De Not.

68. P. MOLLIUSCULA Ach. On dry sterile soil, abundant. War Bonnet Canon, Harrison (Williams), Pine Ridge, Crawford (Webber).

69. P. TILIACEA (Hoffm.) Floerk. var. SUBLÆVIGATA Nyl. On trees. Peru, Weeping Water (Williams).

25. PEZIZACEÆ.

56. **PEZIZA Fuckel.**

70. P. HEMISPHÆRICA Wigg. Manure etc., Wabash (Williams).

26. UREDINEÆ

57. **UROMYCES Link.**

71. U. HOWEI Peck. On Milkweed (*Asclepias syriaca*), Fremont, July 31. Very destructive (Williams).

72. U. TRIFOLII (Alb. & Schw.) Winter. On red clover (*Trifolium pratense*), Ashland. Quite plentiful and somewhat destructive. (Williams).

58. **MELAMPSORA Cast.**

73. M. LINI (DC.) Tul. On Wild-flax (*Linum perenne* var *lewisii*), Hat Creek Basin; Wild-flax (*Linum rigidum*), Weeping Water. Very destructive especially on the latter host. (Williams).

59. **PUCCINIA Pers.**

74. P. ANEMONES-VIRGINIANÆ Schw. On Long fruited anemone (*Anemone cylindrica*), Weeping Water. (Williams).

75. P. FUSCA Relhan. On Anemone, Ashland (Williams).

76. P. HYDROPHYLLI Peck & Cke. On leaves of Water leaf (*Hydrophyllum virginicum*) Sarpy Co. (Pound.)

77. P. MIRABILISSIMA Peck. II & III. On Barberry (*Berberis repens*), Belmont, July 24. The teleutospores are rarely found. In my Nebraska material I found but two. They, however, agree and compare well. (Webber).

78. P. SANICULÆ Grev. On Black snake root (*Sanicula canadensis*), Ashland (Williams).

79. P. SCIRPI DC. III On Bull-rush (*Scirpus* sp.), Lincoln, April (Webber).

80. P. SMILACIS Schw. On Greenbrier (*Smilax hispida*), Ashland. Abundant, causing the leaves to turn yellow and fall off (Williams).

60. **PHRAGMIDIUM Link.**

81. P. SUBCORTICIUM (Schrank.) Wint. Stage I on Rose (*Rosa arkansana*), Milford, May, 86; (Webber). Cultivated Rose (*Rosa* sp.), Lincoln, May (Webber). Weeping Water and Ashland (Williams).

This includes the specimens referred to stage II of *P. speciosum* (No. 416) in the catalogue, but does not include those of stage III.

On leaves petioles and stems, orange red, very conspicuous. Frequently quite injurious (Webber).

61. **ÆCIDIUM Pers.**

82. A. CALLIRRHOES Ell. & Kell. On *Malva* sp. Ashland (Williams).

83. A. MICROPUNCTUM E. & E. On Painted cup (*Castilleja sessiliflora* Pursh), Belmont, June 17. Quite destructive. (Williams.)

62. UREDO Pers.

84. U. RIBICOLA C. & E. On leaves of Buffalo or Missouri currant (*Ribes aureum*), Collected by Dr. Thomas in Scott's Bluff County.

Although determined to be a *Uredo* by Messrs. Cooke and Ellis (Grevillea VI, p. 86) and also by Peck who named it *Uredo jonesii* (Torr. Bull. XII, p. 36) it seems more like a *Coleosporium*, which it will probably turn out to be. All attempts at germinating the spores have thus far failed (Bessey).

27. USTILAGINEÆ.

63. USTILAGO Pers.

85. U. CARICIS (Pers.) Fckl. On Sedge (*Carex filifolia*) Sioux Co. June. Very plentiful, destroying the ovaries of nearly all the host plants in that vicinity. (Williams).

86. U. RABENHORSTIANA Kuhn. On finger grass (*Panicum sanguinale*) Ashland.

On flower spikes in the sheath, completely destroying them (spores brown, echinulate, round ellipsoid or angular, 7–12 by 8–13 m. m. m.). (Williams).

64. UROCYSTIS Rabenh.

87. U. OCCULTA (Wallr.) Rabenh. On Wild rye (*Elymus canadensis*), Ashland. (Williams).

28. EXOASCEÆ.

65. EXOASCUS Fuckel.

88. E. PRUNI Fckl. On common wild plum causing the disease known as "plum pockets." Weeping Water, quite common (Williams), Dawes Co. (Bessey). On *Prunus pumila* at Long Pine (Bessey).

29. SACCHAROMYCETES.

66. SACCHAROMYCES Meyen.

89. S. MYCODERMA Reess. Lincoln (Pound).

30. SPHÆRIOIDEÆ.

67. PHYLLOSTICTA Pers.

90. P. CORNI West. On Red osier dogwood (*Cornus stolonifera*), Belmont, July (Webber.)

91. P. CRUENTA (Fr.) Kx. On False Solomon's seal (*Smilacina stellata*), Ashland (Williams); False Solomon's seal (*S. amplexicaulis*), New Helena, Custer Co., July 6. Frequently quite destructive. (Webber.)

92. P. PERSICÆ Sacc. On leaves of peach. Rock Creek and Ashland (Williams).

93. P. PIRINA Sacc. On apple leaves. Abundant and frequently destructive; Nov. 20. Lincoln. (Webber).

94. P. SEROTINA Cooke. On cherry (*Prunus serotina?*), Richardson Co., Aug. 25. Quite destructive in the locality where the specimens were collected. (Webber).

95. P. ULMICOLA Sacc. On Elm (*Ulmus americana*), Ashland, Oct. (Williams).

68. VERMICULARIA Fr.

96. V. LILIACEARUM Schw. On wild garlic (*Allium canadense*), Ashland (Williams).

69. SEPTORIA Fr.

97. S. BRUNELLÆ Ell. & Hals. On Self-heal (*Brunella vulgaris*), Richardson Co., Aug. 26 (Webber).

98. S. CEPHALANTHI Ell. & Kell. On leaves of Button bush (*Cephalanthus occidentalis*), West Point (Williams).

99. S. CORYLINA Peck. On Hazel nut (*Corylus americana*), Nebraska City, June. Not uncommon. (Webber).

100. S. LITTOREA Sacc. On Dogbane (*Apocynum cannabinum*), Elmwood, Weeping Water, Wabash (Williams).

101. S. RHOINA B. & C. On Sumach. (*Rhus glabra*), Nebraska City, June 1; Common, (Webber). Ashland and Weeping Water (Williams).

70. RHABDOSPORA Mont.

102. R. CONTINUA (B. & C.) Sacc. On stems of Plantain (*Plantago elongata*), Lincoln, March. Forming on old stems, numerous inconspicuous little black specks. (Webber).

31. LEPTOSTROMACEÆ.

71. LEPTOSTROMA, Fr.

103. L. SCIRPINUM Fr. On dead leaves of Riverrush (*Scirpus fluviatilis*), Weeping Water. (Williams.)

32. MELANCONIEÆ.

72. GLŒOSPORIUM Desm. & Mont.

104. G. SPHÆRELLOIDES Sacc. On *Hoya carnosa* in conservatory, Lincoln (Pound).

73. COLLETOTRICHUM Corda.

105. C. LINEOLA Corda. On leaves and culms of False red-top (*Eragrostis pectinacea*), Roca., Sept 22; Sand-bur (*Cenchrus tribuloides*), Lincoln Oct. 3, (Webber).

74. MELANCONIUM Link.

106. M. MAGNUM (Grev.) Berk. On dead Hickory, Ashland (Williams).

33. MUCEDINEÆ.

75. **BOTRYTIS** Mich.

107. **B. CERATIOIDES** Peck. On decaying boards, Weeping Water. (Williams).

76. **RAMULARIA** Ung.

108. **R. DESMODII** Cooke. On leaves of Tick-trefoil (*Desmodium canescens*), Weeping Water, Wabash, Ashland (Williams); Tick trefoil (*D. canadensis*), Lincoln, Aug. (Webber). In places very destructive.

109. **R. IMPATIENTIS** Peck. On leaves of Wild-balsam (*Impatiens fulva* and *I. pallida*), Ashland (Williams).

110. **R. OCCIDENTALIS** Ell. & Kell. On leaves of Dock (*Rumex altissimus*), Lincoln (Pound).

111. **R. OXALIDIS** Farlow. On leaves of Sorrel (*Oxalis violacea*), Ashland (Williams).

77. **STACHYBOTRYS** Corda.

112. **S. LOBULATA** Berk. On decaying broom, Lincoln (Pound).

34. DEMATIEÆ.

78. **CERATOPHORUM** Sacc.

113. **C. ULMICOLUM** Ell. & Kell. On leaves of American Elm (*Ulmus americana*), Ashland, October (Williams).

79. **HELMINTHOSPORIUM** Link.

114. **H. LANCEOLATUM** Cooke. Lincoln (Williams).

80. **CERCOSPORA** Fries.

115. **C. ÆRUGINOSA** Cooke. On leaves of Buckthorn (*Rhamnus lanceolatus*), Ashland (Williams).

116. **C. DATURÆ** Peck. On leaves of Stramonium (*Datura stramonium*), Ashland (Williams).

117. **C. DUBIA** (Riess) Wint. (*C. chenopodii* Fr.)

On Pigweed or goose-foot (*Chenopodium album*), Pine Ridge, July 29 (Webber).

118. **C. ECHINOCYSTIS** Ell. & Mart. On Wild cucumber (*Echinocystis lobata*), Waverly (Williams).

119. **C. FLAGELLARIS** Ell. & Mart. On Poke weed (*Phytolacca decandra*), Richardson Co. Aug. 1 (Webber).

120. **C. GYMNOCLADI** Ell. & Kell. On leaves of Kentucky Coffee tree (*Gymnocladus canadensis*), very common, Ashland (Williams); Richardson Co., Aug. (Webber).

121. **C. LIPPIÆ** Ell. & Ev. On leaves of *Lippia lanceolata*, Ashland. Quite destructive (Williams).

122. **C. SAGITTARIÆ** Ell. & Kell. On Arrow-head (*Sagittaria variabilis*), Weeping Water. (Williams.)

123. C. SYMPHORICARPI Ell. &. Ev. On Indian Currant (*Symphoricarpus vulgaris*), Rock Creek, July (Williams.)

124. C. VERNONIÆ Ell. & Kell. On Iron weed (*Vernonia fasciculata*), Rock Creek, Wabash, Ashland. (Williams). Very plentiful and quite destructive.

35. STILBEÆ.

81. ISARIA Pers.

125. I. SULPHUREA Fiedl. On ground, Lincoln. (Webber).

36. NIDULARIACEÆ.

82. CYATHUS Hall.

126. C. STRIATUS (Huds.) Hoffm. On decaying matter. Wabash, Ashland, Weeping Water. (Williams).

37. LYCOPERDACEÆ.

83. GEASTER Mich.

127. G. HYGROMETRICUS Pers. On ground, Pine Ridge, Dawes Co., July (Webber).

84. BOVISTA Dill.

128. B. SUBTERRANEA Peck. Dismal River, Thomas Co., and Pine Ridge. Very common in Central and Western regions. This species is thought by many mycologists to be identical with *B. circumscissa*, B. & C. (No. 785 of the catalogue). De Toni, (in Sacc. Syl. Fung.) keeps them distinct. Mr. Morgan says he can easily distinguish between the two in the Nebraska material sent him, which, to my certain knowledge, was collected in similar localities. For this reason I insert the species here, although, it is probably nothing more than a form of B. *circumscissa* B. & C. (Webber).

85. LYCOPERDON Tourn.

129. L. CURTISII Berk. Lincoln. (Webber).

130. L. WRIGHTII B. & C. var. SEPARANS Peck. On ground, Dismal River, Thomas Co., July 12; Pine Ridge, July 25 (Webber).

86. ARACHNION Schw.

131. A. ALBUM Schw. On ground among weeds. Lincoln, Aug. (Webber).

38. AGARICINEÆ.

87. LEPIOTA Fr.

132. L. OBLITA Peck. Woods, Weeping Water, Lincoln. Common, (Williams).

88. ARMILLARIA Fr.

133. A. MELLEA Vahl. Base of stumps etc., common, Weeping Water (Williams).

89. TRICHOLOMA Fr.

134. T. TERREUM Schaeff. Woods, Weeping Water. (Williams).

90. CLITOCYBE Fr.

135. C. INFUNDIBULIFORMIS Schaeff. Ashland, rare (Williams).

91. COLLYBIA Fr.

136. C. VELUTIPES Curt. Bases of stumps of Hickory trees. Ashland, Weeping Water, common (Williams).

92. PLEUROTUS Fr.

137. P. ULMARIUS Bull. Trunks of Elm, Boxelder, etc. Generally late in autumn, common. Lincoln, Ashland, Weeping Water (Williams).

93. LENTINUS Fr.

138. L. LECOMTEI Fr. On old logs, especially Cottonwood. Weeping Water, Ashland, Wabash. Common, (Williams).

94. PLUTEUS Fr.

139. P. CERVINUS Schaeff. On much decayed logs, common. Ashland. (Williams).

95. ENTOLOMA Fr.

140. E. RHODOPOLIUM Fr. Moist woods. Ashland (Williams).

96. PHOLIOTA Fr.

141. P. PRÆCOX Pers. Grassy places after rains. Lincoln, Weeping Water. (Williams).

97. HYPHOLOMA Fr.

142. H. VELUTINUM Pers. Lincoln, Weeping Water (Williams).

39. POLYPOREÆ.

98. POLYPORUS Mich.

143. P. ELEGANS (Bull.) Fr. On old wood, Lincoln. A very pretty species with somewhat excentric stipe about 1¾ in. long, thick pileus, and decurrent hymenium. Rare. (Webber).

40. HYDNEÆ.

99. HYDNUM L.

144. H. CIRRATUM Pers. On old stump, Lincoln, June. Mr. Ellis writes — "Rare, I have it also from Iowa and New York." My only specimens were sent to Mr. Ellis for determination hence are in Herb. Ellis.

Hymenium with very long coarse teeth, blue brown. (Webber).

100. IRPEX Fr.

145. I. OBLIQUUS (Schrad.) Fr. On dead limbs of Elm, Ashland (Williams).

41. THELEPHOREÆ.

101. STEREUM Pers.

146. S. NEGLECTUM Pk. (Rep. 33 p. 22.) On bark of trees, common. Lincoln (Webber).

42. CLAVARIEÆ.

102. **PTERULA Fr.**

147. **P. MULTIFIDA Fr. On decaying leaves at bases of trees in heavy timber, rare. Wabash (Williams).**

43. TREMELLINEÆ.

103. **GUEPINA Fr.**

148. **G. SPATHULARIA (Schw.) Fr. On old boards, R. R. ties, etc., common. Weeping Water and Ashland (Williams). Lincoln (Webber).**

44. CHAREÆ.

104. **CHARA (Vaill.) Leonh.**

149. **C. CONTRARIA A. Br. Flowing or standing water and cold springy lakes. Fremont, July (Williams).**

150. **C. FRAGILIS, Desv. In ponds. Greeley Center, Greenwood, Fremont (Williams).**

105. **NITELLA Ag.**

151. **N. ACUMINATA A. Br. var. GLOMERATA A. Br. Ponds near Lincoln (Bessey).**

152. **N. FLEXILIS Ag. Ponds near Minden. In material collected by Dr. Hapeman (Bessey).**

153. **N. MUCRONATA A. Br. Ponds near Minden. In material collected by Dr. Hapeman (Bessey).**

BRYOPHYTA.

45. BRYACEÆ.

106. **GYMNOSTOMUM Hedw.**

154. **G. RUPESTRE Schwægr. (*Mollia æruginosa* (Sm.) Lindb.). On damp overhanging stone cliff. Pine Ridge, July 25 (Webber).**

107. **DICRANELLA Schimp.**

155. **D. VARIA Schimp. On wet clayey soil, banks of the Mo. River. Peru, March (Webber).**

108. **DESMATODON Brid.**

156. **D. ARENACEUS Sulliv. & Lesq. On ground. Collected by Mr. Brunner at Ashland, May (Webber).**

157. **D. NERVOSUS. Bruch. & Schimp. var EDENTULUS Bruch. & Schimp. Abundant on stone. Peru, March (Webber).**

109. **BARBULA. Hedwig.**

158. **B. RURALIS Hedw. Pine Ridge, Aug. 3 (Webber).**

110. BRYUM Dill.

159. B. CÆSPITICIUM L. Earth, Weeping Water (Williams).

111. ATRICHUM Beauv.

160. A. PARALLELUM Mitt. Moist banks. Pine Ridge, June (Williams).

161. A. ANGUSTATUM. Bruch. & Schimp. Long Pine (Bessey).

112. POLYTRICHUM L.

162. P. JUNIPERINUM Willd. On ground. Collected by Mr. Conklin at Long Pine (Webber).

113. HYPNUM Dill.

163. H. FLUVIATILE Swartz. West Nebraska (Webber).

164. H. RADICALE Beauv. On damp decaying log. Hat Creek Basin, Sioux Co. Aug. (Webber).

165. H. RUTABULUM L. var. LONGISETUM Brid. Wet dripping banks and rocks, Ashland, April (Williams).

166. H. SERRULATUM Hedw. On ground. Peru, March; Nebraska City, June (Webber).

PTERIDOPHYTA.

46. MARSILIACEÆ.

114. MARSILIA L.

167. M. VESTITA Hook. & Grev. In ponds in many places in the State; Fairmont, Bradshaw, Minden, Geneva. Apparently not occurring east of the Blue River. The Fairmont specimens collected in 1890 agree with the variety *tenuifolia* in the hairiness, and shape of the leaflets, but nearly all the specimens collected this year (1891) fully agree with the specific characters of *M. vestita*. A few specimens were received which were more hairy, and whose leaflets were narrower, but upon investigation these were found to be terrestrial forms. In some cases these tenuifolia-like forms were connected directly with the larger smooth and broad leaved aquatic forms. The season of 1890 was a very dry one which probably accounts for the small size of the plants and the hairiness and narrow growth of the leaflets (Bessey).

47. FILICES.

115. CHEILANTHES Swz. Lip-fern.

168. C. LANUGINOSA Nutt. Exposed rocks, two miles S. W. of Hackberry Springs, Banner Co. Aug. (Rydberg). Redwillow Co. (Bessey.)

ANTHOPHYTA.

48. NAIADACEÆ.

116. NAIAS L. Naiad.

169. N. FLEXILIS Rostk. & Schmidt. Stagnant water, Greenwood, July (Williams).

117. RUPPIA L. Ditch grass.

170. R. OCCIDENTALIS Watson. In Grand Lake (brackish water), abundant. Alliance Aug. 6. This is the form mentioned in the Catalogue under *Ruppia maritima* as probably belonging to the foreign variety *pedunculata* Hart. Mr. Morong writes: "There can be no doubt that the specimens sent me are *R. occidentalis* Watson, but with some differences. The leaves are somewhat shorter, the peduncles much longer and the fruit somewhat smaller. This form has not hitherto been found this side of Canada." (Webber.)

118. POTAMOGETON L. Pond weed.

171. P. AMPLIFOLIUS Tuckerm. Cropsey's Lake, Lincoln, July (Webber).

172. P. FLUITANS Roth. (*P. lonchites*, Tuckerm.). Streams, etc. Anselmo, Custer Co. July (Webber).

173. P. OAKESIANUS Robbins. In pond, Thedford, Thomas Co., July 11. A rare find. Mr. Morong writes — "It is the first time I have ever known this species to occur so far west. The most westerly locality known for it hitherto has been the Adirondack region in New York." (Webber.)

174. P. PECTINATUS L. Lakes, etc., abundant. Fremont, July (Williams). Grand Lake, Alliance, Aug.; Thedford, Thomas Co., Aug. (Webber).

175. P. SPIRILLUS Tuckerm. Lincoln, July (Webber).

176. P. ZOSTERÆFOLIUS Schum. Springy Lakes. Fremont, July; Greeley Center, July (Williams).

49. HYDROCHARIDACEÆ.

119. ELODEA Michx. Water-weed.

177. E. CANADENSIS Michx. Margins of Cold Lakes. Fremont, July (Williams).

50. ALISMACEÆ.

120. SAGITTARIA L. Arrow head.

178. S. CALYCINA Engelm. Moist Banks, Greenwood, July (Williams).

179. S. HETEROPHYLLA Pursh. Shallow water and muddy banks. Greenwood, July (Williams).

180. S. VARIABILIS Engelm. var. ANGUSTIFOLIA Engelm. Narrow leaves with very narrow diverging lobes. Lodge Pole Creek, Deuel Co., July (Rydberg). Thedford, Thomas Co., Aug. 7; Anselmo, Custer Co., July (Webber).

181. S. VARIABILIS Engelm. var. LATIFOLIA (Willd.) Engelm. With monœcious flowers, broad and acute leaves. Near Platte River, Kearney Co., Aug. (Rydberg). Lincoln, Aug. (Webber).

182. S. VARIABILIS Engelm. var. OBTUSA (Willd.) Engelm. With diœcious flowers and broad and obtuse leaves. Sand Creek below Wahoo, Sanders Co., Sept. (Rydberg).

51. TYPHACEÆ.

121. TYPHA L. Cat-tail flag.

183. T. LATIFOLIA L. var. TRIVIALE (Pursh) B. S. P. Common Cat-tail. Long Pine (Swezey).

52. CYPERACEÆ.

122. CAREX L. Sedge.

184. C. AUREA Nutt. Wooded cañons and low prairies, very common. Lewellen, Alliance (Swezey). Thedford, Thomas Co., July; Hat Creek Basin, Aug.; Pine Ridge, July (Webber).

185. C. DOUGLASII Boott. Dry prairies. Anselmo, Custer Co., July (Webber).

186. C. FILIFOLIA Nutt. Dry places. War Bonnet Cañon, June (Williams). Alliance (Swezey). Hitchcock Co. (Hapeman).

187. C. FILIFORMIS L. var. LATIFOLIA Boeckl. Crete, Alliance (Swezey). Ashland, War Bonnet Cañon (Williams). Pine Ridge, Anselmo, Thedford (Webber).

188. C. GRAVIDA Bailey, var. LAXIFOLIA Bailey. Broken Bow, July 4 (Webber).

189. C. LAXIFLORA Lam. var. VARIANS Bailey. Nebraska City, June 1 (Webber).

190. C. MARCIDA Boott. Dry prairies. Alliance (Swezey). Anselmo, Broken Bow, Thedford (Webber).

191. C. MUHLENBERGII Schkuhr. Low prairies. War Bonnet, Weeping Water, June–July (Williams).

192. C. PENNSYLVANICA Lam. Crete, common (Swezey).

193. C. SARTWELLII Dewey. Ashland, May (Williams).

194. C. SQUARROSA L. Lincoln (Webber).

195. C. STIPATA Muhl. Low prairies, common, Crete (Swezey), Thedford, July 10, Anselmo, July 5 (Webber).

196. C. STRAMINEA Schkr. var. BREVIOR Dewey. Elmwood, June (Williams); Anselmo, Custer Co., July (Webber).

197. C. TETANICA Schkr. Ashland, May (Williams).

198. C. TRIBULOIDES Wahl. var. CRISTATA (Schw.) Bailey. Low ground. Wabash, July 5 (Williams).

199. C. TRICHOCARPA Muhl. var. ARISTATA (R. Br.) Bailey. Low prairies and moist places. Elmwood, Ashland (Williams).

123. **HEMICARPHA Nees.**

200. H. MICRANTHA (Vahl.) Britt. (*H. subsquarrosa* Nees.) Minden. Collected by Dr. Hapeman (Bessey). Ashland (Williams).

124. **ERIOPHORUM L. Cotton grass.**

201. E. GRACILE Koch. Collected at Minden by Dr. Hapeman (Bessey).

125. **FIMBRISTYLIS Vahl.**

202. F. CAPILLARIS (L.) Gray. Long Pine (Swezey). Minden (Hapeman and Bessey).

203. F. CASTANEA Vahl. (*F. spadicea* Vahl. var. *castanea* Gray). Collected by Rev. Bates at Valentine (Rydberg). Minden (Hapeman).

126. **HELEOCHARIS R. Br.**

204. H. ATROPURPUREA (Retz.) Kunth. Collected by Dr. Wibbe in Filmore Co. Reported by Dr. Britton (Torr. Bull. Vol. XVIII, May, 1891, p. 166).

205. H. OVATA (Roth.) R. & S. var. ENGELMANNI (Steud.) Britt. Pine Ridge, June 18 (Williams).

206. H. PALUSTRIS (L.) Roem. & Schult. var. GLAUCESCENS (Willd.) Gray. Anselmo, Custer Co., July 6 (Webber).

127. **DULICHIUM Pers.**

207. D. SPATHACEUM (L.) Pers. Collected by Rev. Bates at Valentine, Aug. 14 (Rydberg).

128. **CYPERUS L.**

208. C. ACUMINATUS Torr. & Hook. Doniphan (Swezey). Lincoln, July 20 (Webber).

209. C. DIANDRUS Torr. Long Pine (Swezey).

210. C. DIANDRUS Torr. var. CASTANEUS Torr. Very abundant, Mo. River bottoms, Richardson Co., Aug. 26 (Webber).

211. C. STRIGOSUS L. Ravenna, Brewster, Long Pine (Swezey).

53. GRAMINEÆ.

129. **ASPRELLA Willd.**

212. A HYSTRIX (L.) Willd. Roadsides N. E. of Wahoo, June (Rydberg).

130. **ELYMUS L. Wild Rye.**

213. E. ELYMOIDES (Raf.) Swezey. (*E. sitanion* Schultes). Lewellen Swezey.

131. **AGROPYRUM Gærtn. Wheat grass.**

214. A. DASYSTACHYUM Vasey. Banks in thin woodlands; War Bonnet, June, 23. Rare (Williams).

132 **BROMUS L. Brome grass.**

215. B. CILIATUS L. var. PURGANS Gray. Belmont (Swezey).

133. **GLYCERIA R. Br. Manna grass.**

216. G. PALLIDA (Eddy) Trin. Wet places at margins of streams. War Bonnet, June 23. Rare (Williams).

134. **POA L. Meadow grass.**

217. P. ALSODES Gray. Woods on hillsides. War Bonnet, June (Williams).

218. P. NEVADENSIS Vasey. Woods in War Bonnet cañon near edges of stream, June 21 (Williams).

219. P. SYLVESTRIS Gray. Edges of woods, War Bonnet, June 23 (Williams).

135. **DIPLACHNE Beauv.**

220. D. FASCICULARIS (Lam.) Beauv. Collected in Minden by Dr. Hapeman and in Rock Co., by Rev. Bates (Bessey). Greenwood (Williams).

136. **AVENA L. Oats.**

221. A. STRIATA Michx. Wild oats. War Bonnet, June (Williams).

137. **ARISTIDA L. Triple-awned grass.**

222. A. TUBERCULOSA Nutt. Collected at Minden by Dr. Hapeman (Bessey).

138. **PANICUM L. Panic-grass.**

223. P. WILCOXIANUM Vasey. Prairies Ft. Niobrara. First collected by Dr. T. E. Wilcox, the post surgeon, and by him submitted to Dr. Vasey who described it as new in Bull. 8, U. S. Dept. Agriculture (Botanical Division) 1889, p. 32.

It is very near *Panicum scoparium* Lam. if indeed it is not a depauperate form of it (Bessey).

54. JUNCACEÆ.

139. **JUNCUS Tourn. Rush, Bog-rush.**

224. J. BALTICUS Dethard var. MONTANUS Engelm. Alliance (Swezey). Broken Bow, July 4; Thedford, July 15 (Webber).

225. J. BUFONIUS L. Sandy ground, not uncommon. Lawrence Fork, Banner Co., Aug. (Rydberg). Broken Bow, July 4; Thedford, July 12 (Webber).

226. J. MARGINATUS Rostk. var. PAUCICAPITATUS Engelm. Brewster (Swezey).

227. J. NODOSUS L. Low prairies and edges of streams, very common. Thedford, Thomas Co., July 14; Anselmo, July 6 (Webber). Long Pine (Swezey).

228. J. TENUIS Willd. var. SECUNDUS Engelm. Long Pine (Swezey).

55. LILIACEÆ.

140. **CALOCHORTUS Pursh.**

229. C. NUTTALLII Torr. & Gr. Along sides of cañons. Pine Ridge, June (Williams).

141. **FRITILLARIA L.**

230. F. ATROPURPUREA Nutt. Along sides of cañons. War Bonnet, June (Williams).

142. **POLYGONATUM Adans. Solomon's seal.**

231. P. BIFLORUM (Walt.) Ell. Cass Co (Williams).

143. **SMILAX L. Greenbrier, Catbrier.**

232. S. HERBACEA L. var PUBERULENTA Gray. Woodlands, War Bonnet, June (Williams).

56. IRIDACEÆ.

144. **IRIS L. Iris, Flag.**

233. I. VERSICOLOR L. Common Blue-flag. Edges of ponds, etc., common. Nebraska City, June (Webber).

57. PONTEDERIACEÆ.

145. **HETERANTHERA Ruiz & Pav. Mud plantain.**

234. H. LIMOSA Vahl. In ponds, common. Lincoln and Fairmont (Bessey). Minden (Hapeman).

58. ORCHIDACEÆ.

146. **HABENARIA Willd. Rein orchis.**

235. H. BRACTEATA (Willd.) R. Br. Moist places, common. War Bonnet, June (Williams).

147. **SPIRANTHES L. Ladies' tresses.**

336. S. CERNUA (L.) Rich. Sand flats, on islands of the Platte River near Ashland. Sept. (Williams).

148. **CORALLORHIZA R. Br. Coral root.**

237. C. INNATA R. Br. Damp dark woods in cañon. War Bonnet, June (Williams).

238. C. MULTIFLORA Nutt. More common than the preceding species. Same locality (Williams).

59. CUPULIFERÆ.

149. **BETULA L. Birch.**

239. B. PAPYRIFERA Marshall. Paper or Canoe birch, White birch. On the north slopes of the bluffs of the Niobrara River near Valentine (Bessey).

60. JUGLANDACEÆ.

150. **HICORIA Raf. Hickory.**

240. H. SULCATA (Willd.) Britt. Richardson Co. (Bessey).

61. SALICACEÆ.

151. **SALIX L. Willow, Osier.**

241. S. ROSTRATA Richardson. Wooded cañons, common. Belmont, July. Hat Creek Basin, Aug. (Webber).

242. S. TRISTIS Ait. Dwarf gray willow. Anselmo, Custer Co., July. Mr. Bebb writes: "This is the most westerly locality of this species known to me." (Webber). Long Pine (Bates).

62. CERATOPHYLLEÆ.

152. **CERATOPHYLLUM L. Honewort.**

243. C. DEMERSUM L. Shallow lakes. Fremont, Greenwood, Ashland. June–Sept. (Williams.)

63. POLYGONACEÆ.

153. **RUMEX L. Dock, Sorrel.**

244. R. BRITANNICA L. Long Pine (Swezey).

154. **POLYGONUM L. Knotweed, Smartweed.**

245. P. HYDROPIPEROIDES Michx. Mild water-pepper. Wet places at edges of water, etc. Wabash, Aug. (Williams).

246. P. LAPATHIFOLIUM L. Belmont (Swezey).

247. P. LAPATHIFOLIUM L. var INCARNATUM (Ell.) Watson. Lawrence Fork, July 8 (Rydberg).

248. P. MUHLENBERGII Watson. Low places. Wabash, Weeping Water, Ashland, Aug.– Sept. (Williams). Horse Creek, Scott's Bluff Co., Aug. 1; Lodge Pole Creek near Kimball, Aug. 12 (Rydberg).

155. **ERIOGONUM Michx.**

249. E. ANNUUM Nutt. f. ——. Sand hills Kearney Co. (Rydberg). Ewing (Bessey).

Of the *E. annuum* type but differing in size, being larger (2–3 ft.); naked above; leaves lanceolate, 2–2½ in. long, ½ in. wide, the upper nearly sessile; bracts triangular; flowers larger than those of *E. annuum*; the dense appressed wooliness turning yellowish on the branches (Rydberg).

250. E. BREVICAULE Nutt. Hills, Kiwa Valley, Scott's Bluff Co., July 28 (Rydberg).

251. E. CERNUUM Nutt. Court House Rock, July 4; Wild Cat Mountains, Banner Co., July 16; Scott's Bluff, July 25; hills near Kimball, Aug. 12; near Sidney, Aug. 16 (Rydberg).

252. E. CORYMBOSUM Benth. Sand draws of Cheyenne Co., Aug. (Rydberg).

253. E. MICROTHECUM Nutt. var. EFFUSUM (Nutt.) Torr. & Gr. Lodge Pole Creek (Swezey).

64. CHENOPODIACEÆ.

156. SUÆDA Forskal. Sea blite.

254. S. PROSTRATA Pallas. (Ill. Pl. Imp. Cogn. p. 55 t. 47.— 1803). (*Salsola depressa*, Pursh Fl. 1814; Watson, in King's Rep.)

Salt Creek Basin N. W. of Lincoln (Rydberg). Differs from *S. linearis* (Ell.) Torr. in having the leaves broadest at the base and one or more of the calyx lobes strongly carinate.

157. EUROTIA Adans.

255. E. LANATA (Pursh) Moq. White sage. Dry prairies, in "Bad lands," etc. Hat Creek Basin, Aug. (Webber). Hillsides, Pumpkin Seed Valley and Lawrence Fork (Rydberg).

A white tomentose undershrub of the aspect of an *Artemisia*. The margins of the leaves are revolute, which separates it at a glance from *Artemisia cana* which it otherwise resembles. It is known under the name of "White sage."

In Coulter's Manual *Eurotia* is described as dicœcious. Watson in his "Revision of N. A. *Chenopodiaceæ*," states that it is sometimes monœcious, which is the case with all specimens found here (Rydberg).

158. ATRIPLEX L.

256. A. ARGENTEA Nutt. Not uncommon in the Salt Basin, N. W. of Lincoln, and saline soil in Kiwa Valley, Scott's Bluff Co. (Rydberg).

257. A. HORTENSIS L. Escaped along roads, etc. Hastings, Aug. 2 (Webber.)

159. MONOLEPIS Schrad.

258. M. CHENOPODIOIDES Moq. Dry saline soil in Deuel Co., June 27 (Rydberg).

160. CHENOPODIUM L. Pigweed, Goosefoot.

259. C. BOSCIANUM Moq. Long Pine, Belmont (?) (Swezey); Bennett, Aug. (Webber.)

260. C. FREMONTII Watson. Collected by Rev. Bates at Alliance (Rydberg); Belmont (Swezey); Anselmo (Webber).

261. C. FREMONTII Watson. var. INCANUM Watson. Collected by Rev. Bates at Valentine (Rydberg). Dry prairies, very abundant in Prairie dog towns, Thedford, July 16 (Webber). Lawrence fork, July 8; Kiwa Valley, Scott's Bluff Co., Aug. 1 (Rydberg).

262. C. LEPTOPHYLLUM Nutt. Common in Central and Western Nebraska. Valentine (Bates). Lodge Pole Creek (Swezey).

Sandy soil, Kearney Co. (Rydberg). Thedford and Anselmo, July (Webber).

263. C. LEPTOPHYLLUM Nutt. var. OBLONGIFOLIUM Watson. Valentine, collected by Rev. Bates; also in broken soil, Deuel Co., July 12 (Rydberg).

264. C. LEPTOPHYLLUM Nutt. var. SUBGLABRUM Watson. Alliance (Swezey). Pine Ridge (Webber). Scott's Bluff, July 24 (Rydberg).

65. AMARANTACEÆ.

161. FRŒLICHIA Moench.

265. F. GRACILIS Moq. "Sand draws," Deuel Co., Aug. 24 (Rydberg).

66. CARYOPHYLLACEÆ.

(Including *Illecebraceæ*.)

162. CERASTIUM L. Mouse-ear, Chickweed.

266. C. ARVENSE L. Collected by Rev. Bates at Ft. Robinson (Bessey). War Bonnet Cañon (Williams).

267. C. VULGATUM L. Crete. (Swezey.)

163. STELLARIA L. Chickweed.

268. S. LONGIFOLIA Muhl. Long-leaved Stitchwort. Low wet banks. Dismal River, Thomas Co., July 12 (Webber).

164. ARENARIA L. Sandwort.

269. A. HOOKERI Nutt. Pine Ridge, July; Hat Creek Basin, Aug. High rocky places, very common.

Dr. Britton after comparison with Nuttall's type of this species refers to it all of my specimens reported in the catalogue as *Arenaria pungens* (Catalogue No. 1213).

Mr. Rydberg has sent me specimens of an *Arenaria* from the cliffs of a cañon in Banner Co., labeled *A. franklini* Dougl. var. *minor* Hook. & Arn. that is probably to be referred here also (Webber).

264½. LOEFLINGIA L.

270. L. SQUARROSA Nutt. High rocky prairies, Belmont, July 18. (Determined by Dr. Britton).

This is a very northerly locality for this plant, its usual range being from Southern California to Texas (Webber).

165. LYCHNIS L. Cockle.

271. L. DRUMMONDII Watson. Dry prairies. Hat Creek Basin, common, June (Williams).

272. L. GITHAGO (L.) Lam. Corn cockle. In cultivated fields. Weeping Water (Williams).

166. **SILENE L.** **Catchfly, Campion.**

273. S. MENZIESII Hook. Woodlands, common. War Bonnet, June (Williams).

274. S. SCOULERI Hook. Pine Ridge, July (Webber).

167. **SAPONARIA L. Soap-wort, Bouncing Bet.**

275. S. VACCARIA L. Crete (Swezey).

168. **ANYCHIA Rich.** **Forked chickweed.**

276. A. CANADENSIS (L.) B. S. P. (*A. dichotoma* Michx. var. *capillacea* Torr.) Woods, Weeping Water, June. Rare (Williams).

67. FICOIDEÆ.

(Luerssen places this under the family *Aizoaceæ*.)

169. **MOLLUGO L.** **Indian chickweed.**

277. M. VERTICILLATA L. Long Pine (Swezey). Minden (Hapeman). Deuel Co. (Rydberg).

68. BERBERIDACEÆ.

170. **CAULOPHYLLUM Michx.** **Pappoose-root.**

278. C. THALICTROIDES (L.) Michx. Blue cohosh. Sarpy Co., May (Pound).

69. RANUNCULACEÆ.

171. **DELPHINIUM L.** **Larkspur.**

279. D. TRICORNE Michx. Dwarf larkspur. Edges of woods. Elmwood, May–June (Williams).

172. **RANUNCULUS L.** **Buttercup, Crowfoot.**

280. R. CIRCINATUS Sibth. Lodge Pole Creek, Cheyenne Co., Aug. 19 (Rydberg).

281. R. HISPIDUS Hook. Irrigated meadow north of Kimball, Aug. 12 (Rydberg).

70. CRUCIFERÆ.

173. **THELYPODIUM Endl.**

282. T. INTEGRIFOLIUM Endl. Fields, etc., not uncommon. Alliance (Swezey). Pine Ridge, July 20 (Webber).

174. **ERYSIMUM L.** **Treacle mustard.**

283. E. ASPERUM DC. Sandy hills in Deuel Co., July. Collected also by Rev. Bates at Valentine.

Pods widely spreading. Large specimens were observed to roll before the wind, thus adding another "Tumble weed" to the already long list (Rydberg).

175. **PHYSARIA Nutt.**

284. P. DIDYMOCARPA Gray. Cañon south of Scott's Bluff, July 22 (Rydberg).

176. **LESQUERELLA Watson.**

285. L. ENGELMANNI (Gray) Watson. Lawrence Fork, Kimball Co., Aug. 11 (Rydberg).

286. L. GRACILIS (Hook.). Watson. Waste ground along railroad. Weeping Water, June.

This is quite a northern extension of its range. It may have been introduced through the agency of the R. R., being found only in this one place. It was, however, abundant and evidently spreading (Webber).

177. **CARDAMINE L.** Bitter cress.

287. C. LACINIATA (Muhl.) Wood. (*Dentaria laciniata* Muhl.) Peru. Communicated by Mr. A. H. Van Fleet (Bessey).

178. **ARABIS L.** Rock cress.

288. A. DENTATA (Torr.) Torr. & Gr. Low ground, rare. Lincoln, April (Webber).

289. A. GLABRA (L.) Bernh. (*A. perfoliata Lam.*). Tower mustard. Dismal River, Thomas Co., July (Webber).

290. A. HOLBŒLLII Hornem. Wooded cañons. Pine Ridge, June (Williams). Pumpkin Seed Valley, July 14 (Rydberg).

179. **NASTURTIUM R. Br.** Water cress.

291. N. OBTUSUM. Nutt. Ft. Clark, Nebraska (Hayden in Engelmann Herb.), Crete (Swezey), Minden (Hapeman), Big Springs (Rydberg).

Prof. Swezey's specimens differ somewhat from typical *N. obtusum*, being less diffusely spreading and branched, approaching likely nearer *N. sinuatum*. Hayden's specimens seem typical (Webber).

292. N. PALUSTRE (L.) DC. var. OVALE Rydberg. In mud, Sand Creek, Wahoo, Sept.

A small plant with the leaves entire, obovate or oval, crenate or with a pair or two of small lobes at the base; pod oval. (Rydberg.)

293. N. SESSILIFLORUM Nutt. Crete (Swezey). Wahoo Creek below Wahoo, Sept. (Rydberg). Lincoln, May (Webber).

294. N. SINUATUM Nutt. Moist places along banks, Elmwood, June (Williams), Fairbury (in Herb. Univ. of Nebr.). Omaha and Crete (Swezey). Platte River, Kearney Co., June 15 (Rydberg). Lincoln, May; Nebraska City, June (Webber). Pods and pedicels variously curved, forming a conspicuous character.

71. CAPPARIDACEÆ.

180. **CRISTATELLA Nutt.**

295. C. JAMESII Torr. and Gr. Collected by Rev. Bates at Valentine, Aug. 1 (Rydberg).

72. HYPERICACEÆ.

181. **HYPERICUM** L. St. John's-wort.

296. H. CANADENSE L. Common in low grounds. Thedford, July 14 (Webber). Ashland (Williams). *H. mutilum* L. of Swezey's Nebr. Fl. Plants p. 5, is probably to be referred here.

297. H. CANADENSE L. var. MAJUS Gray. Wet Meadows. Saunders Co., June (Rydberg). Lowell, July 11 (Webber).

298. H. VIRGINICUM L. (*Elodes virginica* Nutt. and *E. campanulata* Pursh). Antelope Co. (Webber).

73. GERANIACEÆ.

182. **ERODIUM** L' Her. Storksbill.

299. E. CICUTARIUM (L.) L'Her. Alfilaria. Lincoln. Along sidewalks, probably introduced in hay. Adventive from Europe (Williams).

74. LINACEÆ.

183. **LINUM** L. Flax.

300. L. RIGIDUM Pursh. Prairie flax. Very common on the prairies of central and western Nebraska. Superior, Brewster, Long Pine, Lewellen (Swezey); Deuel Co., July (Rydberg); Thedford, July 14; Anselmo, July; Broken Bow, July; Belmont, Aug. (Webber).

A form collected at Hat Creek Basin Aug. 2, Prof. Trelease notes as having the habit of var. *puberulum* Engelm. (Webber).

301. L. USITATISSIMUM L. Cultivated Flax. Escaped to low prairies. Broken Bow, July (Webber).

75. SAPINDACEÆ.

184. **ÆSCULUS** L. Horse-chestnut, Buckeye.

302. A. GLABRA Willd. Richardson and Pawnee counties (Bessey).

76. EUPHORBIACEÆ.

185. **EUPHORBIA** L. Spurge.

303. E. CUPHOSPERMA (Engelm.) Boiss. A few specimens collected Aug., 1890, in a cañon running north from Lawrence Fork, Banner Co.

Leaves lance linear, entire or with a few teeth on the revolute margin. Seeds short, triangular, truncate at the base, wrinkled and tuberculate, with a minute caruncle. Belongs to the *E. heterophylla* group (Rydberg).

304. E. FENDLERI Torr. & Gr. "Sand draw," Cheyenne Co., Aug.

The seeds are described in Coulter's Manual as irregularly punctate. In the original description in Pacific R. R. Rep. it reads "a little rugose transversely," which agrees with Nebraska specimens (Rydberg).

305. E. GEYERI Engelm. Collected by Rev. Bates at Valentine, July 1 (Rydberg).

77. UMBELLIFERÆ.

186. **BERULA** Koch.

306. B. ANGUSTIFOLIA (L.) Koch. In water, Hackberry Springs, Banner Co., Aug. (Rydberg); Long Pine, Lewellen, Belmont (Swezey); Anselmo, Thedford, July–Aug. (Webber).

187. **CYMOPTERUS** Raf.

307. C. GLOMERATUS Raf. Lewellen, Alliance (Swezey). Collected by Rev. Bates at Valentine, May (Rydberg).

188. **PASTINACA** L. Parsnip.

308. P. SATIVA L. Common parsnip. Introduced. Mead, Saunders Co., June, 1890 (Rydberg).

78. ARALIACEÆ.

189. **ARALIA** L. Wild sarsaparilla.

309. A. RACEMOSA L. Spikenard. Nebraska City, Aug. (Williams).

79. SAXIFRAGACEÆ.

190. **RIBES** L. Currant, Gooseberry.

310. R. GRACILE Michx. Wild gooseberry. Saunders Co. This is the common wild gooseberry of Saunders Co., and Eastern Nebraska. It differs from *R. rotundifolium* Michx. in having long and slender peduncles, and capillary filaments 4–6″ long. The majority of Nebraska specimens referred to *R. rotundifolium* Michx. likely belong here (Rydberg).

80. CACTACEÆ.

191. **OPUNTIA** Tourn.

311. O. RUTILA Nutt. Prairies. Deuel Co., June 23 (Rydberg).

81. ONAGRACEÆ.

192. **ŒNOTHERA** L. Evening primrose.

312. Œ. ALBICAULIS Nutt. var. RUNCINATA Engelm. "Sand draws," Deuel Co., Aug. (Rydberg). Very likely this is the sinuate leaved form of *Œ. albicaulis* referred to in the Catalogue Fl. Nebr. No. 1404.

313. Œ. BIENNIS L. var. PARVIFLORA Gray. Petals hardly ½ in. long. Hills, Deuel Co. (Rydberg).

314. Œ. HARTWEGII Benth. var. LAVANDULÆFOLIA (Torr. & Gr.) Watson. Prairies, etc. Lisbon, Perkins Co., June 23; Deuel Co., June 27 and July 2: Pleasant Valley, Scott's Bluff Co., July 28; Banner Co., Aug. (Rydberg). Lewellen, rare (Swezey).

315. Œ. SPECIOSA Nutt. Lincoln, probably an escape from cultivation (Bessey).

193. EPILOBIUM L. Willow herb.

316. E. HORNEMANNI Richenb. Belmont? (*E. alpínum* L. of Swezey's Nebr. Fl. Plants, p. 8.).

82. ROSACEÆ.

194. POTENTILLA L. Five-finger.

317. P. ANSERINA L. Silver-weed. Lewellen (Swezey).

318. P. RIVALIS Nutt. var. PENTANDRA (Engelm.) Watson. Wabash, July (Williams).

319. P. SUPINA L. Omaha, Lewellen (Swezey).

195. CERCOCARPUS H. B. K. Mt. Mahogany.

320. C. PARVIFOLIUS Nutt. Rocky hills, Banner Co., Aug. A shrub 3–6 ft. high. Seen at a distance it gives the hills a peculiar dark grayish color caused partly by the beautiful plumy tails of the fruit (Rydbe rg).

83. LEGUMINOSÆ.

196. AMPHICARPÆA Ell.

321. A. PITCHERI Torr. & Gr. Banks of Sand Creek below Wahoo. Sept. (Rydberg). Woods, Ashland (Williams).

Leaflets larger than in *A. comosa*; rachis villous; bracts large, silky canescent; upper flowers commonly fertile (Rydberg).

197. LATHYRUS L.

322. L. ORNATUS Nutt. Differs from *L. polymorphus* in having linear lanceolate leaves and the seed with a broad stalk and long hilum

Pierce, Ft. Robinson (Herb. Univ. of Nebr.), Phelps Co., Fremont (Rydberg).

A light yellow form of *L. ornatus Nutt.* is also sometimes found, Collected by Miss H. G. Wilkenson at Gordon. Fremont (Rydberg).

198. ASTRAGALUS L. Rattle-weed.

323. A. CHAMÆLUCE(?) Gray. Alliance, Lewellen(Swezey, Nebr. Flowering Plants, p. 7).

(The specimens differ from typical *A. chamæluce* in having too small flowers and too many leaflets. More abundant material is necessary to satisfactorily place the species. — Webber.)

324. A. PICTUS Gray. var. FILIFOLIUS Gray. Lewellen, rare; Alliance (Swezey). Collected by Rev. Bates at Valentine (Rydberg).

199. PETALOSTEMON Michx. Prairie clover.

325. P. COMPACTUS (Spreng.) Swezey. (*P. macrostachyus* Torr.) Lewellen (Swezey).

326. P. TENUIFOLIUS Gray. "Sand draws," Deuel Co., July.

Low, branching from below, decumbent; leaflets 1–2 pairs

linear-filiform, revolute; bracts ovate, densely villous, as is also the calyx, with grayish, slightly tawny hairs (Rydberg).

327. P. SP.———. *P. candidus* var. *occidentalis* Gr. of Pringle's collection, according to Dr. Britton. It is, however, clearly no variety of *P. candidus*, but may be of *P. gracilis*, Nutt., of the south, to which it is nearly related. It differs from *P. gracilis* in having more oblong leaves, longer more lax spikes, and glandular dotted calyx. Dr. Britton says if distinct from *P. gracilis* it is clearly a distinct species (Rydberg).

200. PSORALEA L. Psoralea.

328. P. DIGITATA Nutt. Aurora (Williams). Much confounded with *P. campestris*. Specimens in the Herb. of Univ. of Nebr. collected at Anselmo by Webber and at Valentine by Rev. Bates, evidently belong here. Nebraska specimens collected by Dr. Bessey, have been referred to *P. digitata* by Dr. Britton (Rydberg).

329. P. FLORIBUNDA Nutt. This species, I think, should not be merged into *P. tenuiflora* Pursh. It is either a distinct species or a well marked variety. *P. floribunda* Nutt. found in eastern Nebraska has generally 5 oblong leaflets, 1–1½ in. long; many flowered racemes; lower calyx teeth longer; and larger flowers. *P. tenuiflora* Pursh, of western Nebraska, has 3 oblong-oblanceolate leaflets, ½–¾ in. long; few flowered racemes; and punctate, colored calyx with equal teeth. Dr. Britton, to whom specimens and my notes upon them have been sent says: "I had concluded that *P. floribunda* could not go unnoticed into *P. tenuiflora*." The matter needs more investigation. Most of the localities for *P. tenuiflora* in the catalogue of Nebr. Flora belong to *P. floribunda*. The only specimens of the true *P. tenuiflora* I have seen are those collected by Dr. Bessey, at Ft. Robinson, and my own, from the plains of Deuel Co., Aug. 1890 (Rydberg).

330. P. HYPOGÆA Nutt. Alliance, Lewellen (Swezey). Hills, Deuel Co., June 26 (Rydberg).

331. P. LINEARIFOLIA Torr. & Gr. Magnesia cliffs in Deuel Co., July.

Racemes very loose, 3–6 in. long; leaflets 3, linear, 1–2 in. long; stem, leaves, and calyx glandular dotted (Rydberg).

201. TRIFOLIUM L. Clover, Trefoil.

332. T. PROCUMBENS L. Low hop-clover. Yards and roadsides, Lincoln. Adventive from Europe (Webber).

202. LUPINUS L. Lupine.

333. L. ARGENTEUS Pursh var. ARGOPHYLLUS Watson. Prairies rare. War Bonnet, June (Williams).

334. L. ARGENTEUS Pursh var. DECUMBENS Watson. "Sand draws," 2 miles S. W. of Hackberry Springs, Aug. (Rydberg). Prairies of Hat Creek Basin, common (Webber).

335. L. PUSILLUS Pursh. Lewellen (Swezey). Hills near Curtis. Frontier Co., June 23; Deuel Co., June 25 (Rydberg).

84. ERICACEÆ.

203. MONOTROPA L. Indian pipe, Corpse-plant.

336. M. UNIFLORA L. Washington and Cass Counties (Bessey).

204. PYROLA. Tourn. Wintergreen, Shin-leaf.

337. P. CHLORANTHA Sw. Damp dark wooded cañons, rare. War Bonnet, June (Williams).

338. P. SECUNDA L. Damp cañon at head of Jim Creek, Pine Ridge, June 25. Very rare (Williams).

205. ARCTOSTAPHYLOS Adans. Bearberry.

339. A. UVA-URSI (L.) Spreng. In a cañon near Anselmo, Custer County. The occurrence of this plant in the center of the state, hundreds of miles from any of its known stations, adds another puzzle to the many connected with the geographical distribution of the plants of the plains. It is known to occur in the Black Hills of South Dakota and the Rocky Mountains in Wyoming and Colorado. In Minnesota it is found near Pepin; it is absent from Iowa, while in Missouri it is confined to the southeastern part. It is doubtfully reported as occurring in Kansas. That it should be found in Central Nebraska is certainly unexpected (Bessey).

85. PRIMULACEÆ.

206. CENTUNCULUS Dill. Chaffweed.

340. C. MINIMUS L. Fairfield (Swezey).

207. LYSIMACHIA Tourn. Loosestrife.

341. L. THYRSIFLORA L. Tufted Loosestrife. Collected by Rev. Bates at Valentine, June (Rydberg); Lewellen (Swezey); Platte River near Doniphan, May (Harvey Thompson).

208. DODECATHEON L. American cowslip.

342. D. MEADIA L. Shooting-star. Alliance (Swezey).

86. CONVOLVULACEÆ.

209. CUSCUTA L. Dodder, Love-vine.

343. C. TENUIFLORA Engelm. Crete, on *Salix* (Swezey).

210. CONVOLVULUS L. Bindweed.

344. C. ARVENSIS L. Bindweed. Roadsides. Ashland, May (Williams).

87. POLEMONIACEÆ.

211. GILIA Ruiz & Pav.

345. G. GRACILIS Hook. "Sand draws" in Deuel Co., June 25 (Rydberg). War Bonnet Cañon (Williams).

316. G. LINEARIS (Nutt.) Gray. Sides of cañon, Squaw Creek, June

(Williams). Dry banks, common: Pine Ridge, July 18; Hat Creek Basin, Aug. 1 (Webber). "Sand draws" in Deuel Co., June 25 (Rydberg).

347. G. MINIMA Gray. Collected at Rushville, in July, by Rev. Bates (Rydberg).

348. G. PUNGENS Benth. var CAESPITOSA Gray. Hills in Kiwa Valley, July 22; Scott's Bluff, July 25 (Rydberg).

88. HYDROPHYLLACEÆ.

212. PHACELIA Juss.

349. P. CIRCINATA (Willd.) Jacq. Abundant in dry cañons. Pine Ridge, July (Webber). War Bonnet (Williams).

Very *Krynitzkia* like in appearance. Venation prominent above and below, leaf pinnately and obliquely straight veined. Lower leaves seldom with lateral leaflets in Nebraska specimens (Webber).

89. BORRAGINACEÆ.

213. LITHOSPERMUM L. Gromwell, Puccoon.

350. L. LATIFOLIUM Michx. Superior (Swezey).

351. L. PILOSUM Nutt. War Bonnet, June (Williams).

214. MERTENSIA Roth.

352. M. LANCEOLATA (Pursh) DC. Wooded cañons. War Bonnet, June (Williams).

(Prof. Swezey's specimens from Lewellen and Chadron referred to this species, Nebr. Flowering Plants, p. 11, must be considered as belonging to *Pentstemon cæruleus* Nutt.—Webber.)

215. CRYPTANTHE Lehmann. [*Krynitzkia crassisepala* Gray and *K. glomerata* Gray, No's. 1577 and 1578 of the Catalogue of Neb. Flora, should be changed according to Prof. Greene's paper (Pittonia, I. p. 110–112) to *Cryptanthe glomerata* Lehmann and *C. crassisepala* (T. & G.) Greene.]

353. C. FENDLERI (Gr.) Greene l. c. (*Krynitzkia fendleri* Gray). Dry cañons, etc. "Bad lands." Hat Creek Basin, Sioux Co., Aug. (Webber). Lodge Pole Creek (Swezey). Collected by Rev. Bates at Harrison, Aug. Wild Cat Mts., Banner Co., July 17 (Rydberg).

216. OREOCARYA Greene. Pittonia I. p. 57.

354. O. FULVOCANESCENS (Gray) Greene, l. c. (*Krynitzkia fulvocanescens* Gray). Dry sterile places, War Bonnet, June (Williams); Hat Creek Basin, Aug. (Webber).

355. O. SUFFRUTICOSA (Torr.) Greene, l. c. (*Eritrichium jamesii* Torr. *Krynitzkia jamesii* (Torr.) Gray). Quite common in the western part of the state. Alliance (Swezey); Deuel Co.; Lawrence

Fork, Banner Co., Aug. (Rydberg); Harrison (Bates); Belmont, July; Hat Creek Basin, Aug. (Webber).

217. ECHINOSPERMUM Swartz. Stickseed.

356. E. DEFLEXUM (Wahl.) Lehm. var. AMERICANUM Gray. Long Pine (Swezey).

357. E. FLORIBUNDUM Lehm. Lawrence Fork, Banner Co., July 17 (Rydberg).

90. SOLANACEÆ.

218. PHYSALIS L. Ground cherry.

358. P. LANCEOLATA Michx. var. HIRTA Gray. Prairies. Hat Creek Basin, June (Williams).

Mr. Rydberg has noted two forms or varieties of *Physalis* belonging to the *lanceolata* group but differing enough from *P. lanceolata* to be distinct. I give below his descriptions in brief:—

No. 1. Glabrous or minutely hirsute on the calyx and the angles of the stems, erect, branched above; corolla yellowish with darker spot, only 5–7 lines across; anthers yellow; fruiting calyx inversely pear shaped; fruit greenish yellow; leaves lanceolate, sparingly toothed. "Sand draws," Deuel and Banner Co.'s July, 1890 (Rydberg).

No. 2. Slender, ascending; leaves oblong, lanceolate to oblanceolate, entire; calyx hispid; corolla, anthers, and fruit like the preceding; fruiting calyx globose. Near Pumpkin Seed Creek, Banner Co., Aug. 1890 (Rydberg).

91. SCROPHULARIACEÆ.

219. PEDICULARIS L. Louse wort.

359. P. CANADENSIS L. Bottom lands, common. Ashland, May (Williams).

360. P. LANCEOLATA Michx. Moist woods, rare. Ashland. Sept. (Williams).

220. GERARDIA L. Gerardia.

361. G. TENUIFOLIA Vahl. var. MACROPHYLLA Benth. Dry woods, common. Ashland, Weeping Water (Williams).

221. LIMOSELLA L. Mudwort.

362. L. AQUATICA L. Spring in Deuel Co., June 27 (Rydberg).

222. MIMULUS L. Monkey flower.

363. M. LUTEUS L. Lewellen (Swezey).

223. PENTSTEMON Mitchell. Beard tongue.

364. P. HAYDENI Watson. (Bot. Gazette, XVI (Nov., 1891), p. 311)

Sandy prairies in central Nebraska, quite common. It is frequently found in the edges of "blow outs." Antelope Co.) July; Dismal River, Thomas Co., July 12 (Webber).

This includes *Pentstemon glaber* Pursh var *utahensis* Watson, of Swezey's Nebr. Fl. Plants, p. 12; from Lewellen.

The habit is rather peculiar, growing as it does in very loose sandy places, the sand blowing here and there frequently banking up around it, modifies leaves and stems already formed. It is usually ascending, the lower portion of the stem running for some distance under the loose sand with no modification except a reduction of the leaves from lanceolate to linear and finally to filiform, or to mere scales. Many of the linear ones are quite long and expand somewhat above if the surface is reached (Webber).

92. OROBANCHACEÆ.

224. APHYLLON Mitchell. Cancer root, Naked broom rape.

365. A. FASCICULATUM Gray. var. LUTEUM Gray. Collected by Rev. Bates at Valentine, June 10. Hills south of Scott's Bluff, July 26 (Rydberg).

93. LABIATÆ.

225. STACHYS L. Hedge-nettle.

366. S. ASPERA Michx. var. TENUIFLORA (Willd.) Hitchcock, Cat. Anth. & Pter. of Ames, Ia., p. 513. (*Stachys aspera* Michx, var. *glabra* Gray). Banks of Wahoo Creek, Saunders Co., Aug. (Rydberg.)

367. S. PALUSTRIS L. Collected by Rev. Bates at Valentine (Rydberg); Kearney, June (Webber).

226. PHYSOSTEGIA Benth. False dragon-head.

368. P. PARVIFLORA Nutt. Spring near Horse Creek, Scott's Bluff Co. Aug. 1 (Rydberg).

227. SCUTELLARIA L. Skullcap.

369. S. GALERICULATA L. Lewellen (Swezey). Spring, near Horse Creek, Scott's Bluff Co., Aug. 1 (Rydberg).

228. MONARDA L. Horse-mint.

370. M. FISTULOSA L. var MOLLIS (L.) Benth. Wild bergamot. Banks of ravines, etc., Wahoo, Aug. (Rydberg).

229. SALVIA L. Sage.

371. S. AZUREA Lam. var. GRANDIFLORA Benth. Crete (Swezey).

230. MENTHA L. Mint.

372. M. CANADENSIS L. var. BOREALIS (Michx) Wood. (*M. canadensis* L. var. *glabrata* Benth.) Remarkable for its sweet scent. Hackberry Springs, Banner Co., Aug. (Rydberg). Cass Co. (Williams).

373. M. SATIVA L. Whorled mint. River banks, rare. Fremont, July (Williams).

94. VERBENACEÆ.

231. VERBENA L. Vervain.

374. V. BRACTEOSA x HASTATA. In a pasture 1 mile W. of Mead, Saunders Co., in June, 1890, there were found a few specimens of a Verbena, which undoubtedly is a hybrid between *V. bracteosa* Michx. and *V. hastata* L. The specimens are of the size and general appearance of *V. hastata*, but branched from the base and ascending. The leaves are of the size of those of *V. hastata* but more divided like those of *V. bracteosa*. The bracts are like those of the latter. Dr. Engelmann mentions several Verbena hybrids but not this (Rydberg).

375. V. OFFICINALIS L. Cultivated grounds and pastures, Wabash, July. Adventive from Europe (Williams). Tecumseh (Bessey).

232. LIPPIA L.

376. L. LANCEOLATA Michx. Low meadows, Ashland, July–Aug. Common (Williams). Richardson Co., Aug. (Webber). Minden (Bessey).

95. PLANTAGINACEÆ.

233. PLANTAGO L. Plantain, Ribwort.

377. P. LANCEOLATA. Roadsides, yards, etc.; becoming abundant. Introduced. Ashland (Williams); Lincoln (Webber, Smith, Williams); Crete (Swezey); Aurora (Bessey).

378. P. PATAGONICA Jacq. var. ARISTATA (Michx.) Gray. Hastings (Bessey).

96. OLEACEÆ.

234. FRAXINUS L. Ash.

379. F. AMERICANA L. White ash. Sarpy and Nemaha Counties (Bessey).

97. GENTIANACEÆ.

235. GENTIANA L. Gentian.

380. G. FLAVIDA Gray. (*G. alba.* Muhl.) White Gentian. Low ground. Nemaha Co., Aug. (Webber); Weeping Water (Williams).

236. MENYANTHES L. Buckbean.

381. M. TRIFOLIATA L. Ponds, Cherry County (Bessey).

237. ERYTHRÆA Richard. Centaury.

382. E. DOUGLASII Gray. On the sands of the Platte River in Scott's Bluff Co., Aug. 1 (Rydberg).

98. ASCLEPIADACEÆ.

238. ACERATES Ell. Green milkweed.

383. A. AURICULATA Engelm. Lewellen, rare (Swezey). "Sand-draws" in Deuel Co., July (Rydberg).

It is easily mistaken for *Asclepias stenophylla* from which it can not be distinguished except by the form of the hood and its auricles (Rydberg).

384. A. VIRIDIFLORA (Raf.) Ell. var. LANCEOLATA (Ives) Gray. Hills, Wahoo, June, 1890 (Rydberg).

99. COMPOSITÆ.

239. STEPHANOMERIA Nutt.

385. S. MINOR Nutt. "Bad lands" north of Scott's Bluff, July 22.

It is easily mistaken for a *Lygodesmia* (Rydberg).

240. LACTUCA L. Lettuce.

386. L. INTEGRIFOLIA Bigel. Roadsides, Weeping Water (Williams).

241. CREPIS L.

387. C. INTERMEDIA Gray. Side of cañon, plentiful. War Bonnet, June (Williams).

388. C. RUNCINATA (James) Torr. & Gr. Collected by Rev. Bates at Valentine (Rydberg). Lewellen (Swezey). Platte bottoms, Cheyenne Co., July 3; Pumpkin Seed Valley, July 14 (Rydberg).

242. CICHORIUM L. Succory, Chicory.

389. C. INTYBUS L. Yards, Lincoln, Introduced (Webber).

243. CNICUS L. Thistle.

390. C. ALTISSIMUS (L.) Willd. var. FILIPENDULUS Gray. Belmont (Swezey).

391. C. UNDULATUS (Nutt.) Gray, var. CANESCENS (Nutt.) Gray Prairies, common. Antelope Co., Pine Ridge, July–Aug.

A form from Pine Ridge has conspicuously decurrent leaves, a character shown also by a specimen of Hayden's in the Engelmann Herbarium from the Sand hills of the Plains.

Cnicus pitcheri Torr., No. 1738 of the Cat. of the Fl. of Nebr. belongs here (Webber).

392. C. UNDULATUS (Nutt.) Gray, var. MEGACEPHALUS Gray. Broken Bow, July 4 (Webber).

244. ARNICA L.

393. A. CORDIFOLIA Hook. Hillsides, rare. Squaw Cañon, Pine Ridge, July (Williams).

245. HELENIUM L.

394. H. AUTUMNALE L. Sneeze-weed. Collected by Rev. Bates at Valentine (Rydberg); Minden (Hapeman).

246. PECTIS L.

395. P. ANGUSTIFOLIA Torr. "Sand draws" Deuel Co., July.

A little plant (1-3 in. high) with glandular punctate leaves and pleasant odor (Rydberg).

247. THELESPERMA Lees.

396. T. AMBIGUUM Gray. Prairies, quite common. Long Pine (Swezey); Alliance, July; Crawford, Aug.; Belmont, July (Webber).

397. T. FILIFOLIUM (Hook.) Gray. Table land, Banner Co., Aug. Collected also by Rev. Bates at Valentine (Rydberg).

248. COREOPSIS L. Tickseed.

398. C. ARISTOSA Michx. Long Pine (Swezey).

399. C. TRICHOSPERMA (?) Michx. var. TENUILOBA Gray. Lewellen, Alliance (Swezey in Nebr. Flowering Plants). (This has the character of *Thelesperma* and will likely prove to be near *T. ambiguum*. — Webber).

249. HELIANTHUS L. Sunflower.

400. H. DECAPETALUS (?) L. Crete (Swezey Nebr. Flowering Plants, p. 10).

(This is near *H. tuberosus* L. to which it may have to be referred.— Webber).

250. ECLIPTA L.

401. E. ALBA (L.) Haussk. Crete (Swezey).

251. FRANSERIA Cav.

402. F. HOOKERIANA Nutt. Alliance (Swezey). Lodge Pole Creek, near Potter, Aug. 15 (Rydberg).

403. F. TOMENTOSA Gray. Becoming a troublesome weed on low rich soil in Kearney Co. (Rydberg).

252. AMBROSIA L. Ragweed.

404. A. TRIFIDA L. var. INTEGRIFOLIA (Muhl.) Torr & Gr. With the type in various places. At Hackberry Springs only this form was found (Rydberg); Lincoln (Bessey); Minden (Hapeman).

253. IVA L.

405. I. AXILLARIS Pursh. Near Platte River, Scott's Bluff Co., July 25 (Rydberg).

254. ANTENNARIA Gærtn. Everlasting.

406. A. DIMORPHA Torr. & Gr. Collected at Harrison by Rev. Bates (Bessey).

407. A. DIOICA (L.) Gaertn. Alliance (Swezey); Belmont, July 14 (Webber).

255. ERIGERON L. Fleabane.

408. E. CANUS Gray. Lawrence Fork, Banner Co., Aug. (Rydberg).

409. E. CÆSPITOSUS Nutt. Prairies, not uncommon. Hat Creek Basin, Aug.; Belmont, July (Webber).

410. E. CONCINNUS Torr. & Gray. Dry prairies. War Bonnet, June (Williams).

411. E. MACRANTHUS Nutt. Cañons, etc. Hat Creek Basin, Aug. 2.

(Prof. Swezey's specimens of *E. glabellus* Nutt. from Long Pine (Neb. Flowering Plants, p. 9) probably belong here, although differing somewhat from the type in having a hairy involucre. My specimens also show this peculiarity but were pronounced by Dr. Watson to be *E. macranthus*.— Webber.)

412. E. PUMILUS Nutt. Collected by Rev. Bates at Valentine (Rydberg); War Bonnet, June (Williams); Lewellen (Swezey); Pine Ridge, July; Hat Creek Basin, Aug. (Webber).

Quite common on dry prairies.

256. ASTER L. Aster.

413. A. AZUREUS Lindl. Weeping Water (Williams).

414. A. ERICÆFOLIUS Rothrock. Prairies, Venango, Perkins Co., June 23 (Rydberg).

415. A. FOLIACEUS Lindl. Platte River north of Scott's Bluff, July 23; Horse Creek, Aug. 1; Lodge Pole Creek, near Kimball, Aug. 12 (Rydberg).

416. A. PANICULATUS Lam. Low prairies, very common, Lincoln, Sept. (Webber).

417. A. PUNICEUS L. Prairies. Clear water, Antelope Co., Sept. (Webber).

418. A. TRADESCANTI L. Crete, common (Swezey, Nebr. Fl. Pl., p. 9.)

(The specimens of this seem to me to be nearer *A. paniculatus*. Its occurrence in Nebraska needs confirmation.—Webber.)

257. TOWNSENDIA Hook.

419. T. SERICEA Hook. Prairies, not uncommon. Collected by Dr. W. A. Thomas in Hayes Co., April (Rydberg); McCook; Alliance; Ogalalla (Swezey); Antelope Co. (Webber).

258. SOLIDAGO L. Golden rod.

420. S. CANADENSIS L. var. PROCERA Torr. & Gr. Weeping Water (Williams).

421. S. NEMORALIS Ait. var. INCANA (Torr. & Gr.) Gray. Hills, Deuel Co., Aug. (Rydberg); Lewellen; Alliance; Lodge Pole Creek; Belmont (Swezey).

422. S. RADULA Nutt. Edges of thickets, Weeping Water (Williams).

423. S. SEROTINA Ait. var. GIGANTEA (Ait.) Gray. Saunders Co., Sept. (Rydberg).

424. S. SPECIOSA Nutt. Prairies, Ashland, June (Williams).

259. HAPLOPAPPUS Cass.

425. H. NUTTALLII Torr. & Gr. "Sand draws," of Banner Co. (Rydberg). Denuded places, in "Bad Lands," Hat Creek Basin, Sioux Co., Aug. (Webber).

426. H. RUBIGINOSUS (?) Torr. & Gr. Lodge Pole Creek (Swezey, Nebr. Fl. Pl., p. 9).

(Prof. Swezey's specimens are rather meager to decide upon, and as Nebraska is somewhat out of the known range of the species, its occurrence may perhaps remain in question until confirmed.)

260. **CHRYSOPSIS Nutt.** **Golden aster.**

427. C. VILLOSA (Pursh) Nutt. var. CANESCENS (DC.) Gray. "Sand draws," Deuel and Banner Co.'s (Rydberg).

428. C. VILLOSA (Pursh) Nutt. var. HISPIDA (Hook.) Gray. "Sand draws," Deuel Co. (Rydberg). Long Pine (Conklin, Swezey).

429. C. VILLOSA (Pursh) Nutt. var. SESSILIFLORA (Nutt.) Gray. "Sand draws," Banner Co. (Rydberg).

261. **BRICKELLIA Ell.**

430. B. GRANDIFLORA (Hook.) Nutt. In a cañon, Banner Co. (Rydberg).

262. **VERNONIA Schreb.** **Iron weed.**

431. V. ALTISSIMA Nutt. Banks, etc. Wahoo, Saunders Co., Sept. (Rydberg).

432. V. NOVEBORACENSIS (L.) Willd. Bottom meadows, Ashland, Aug. (Williams).

NOTE.—By a misinterpretation of Mr. Rydberg's manuscript, *Nasturtium palustre* (L.) DC. var. *ovale* M. (No. 292 of this appendix), appears as *N. palustre* (L.) DC. var. *ovale* Rydberg.

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VOL. VI. No. 2.

A GEOMETRICAL CONSTRUCTION FOR FINDING THE FOCI OF THE SECTIONS OF A CONE OF REVOLUTION.

EDMUND A. ENGLER.

Issued April 15, 1892.

A GEOMETRICAL CONSTRUCTION FOR FINDING THE FOCI OF THE SECTIONS OF A CONE OF REVOLUTION.*

EDMUND A. ENGLER.

Fig. 1 represents a meridian section of a cone of revolution. S is the vertex, and SC_2 is the axis of the cone; SD_1 and SD_2 are the elements cut from the cone by the plane of the

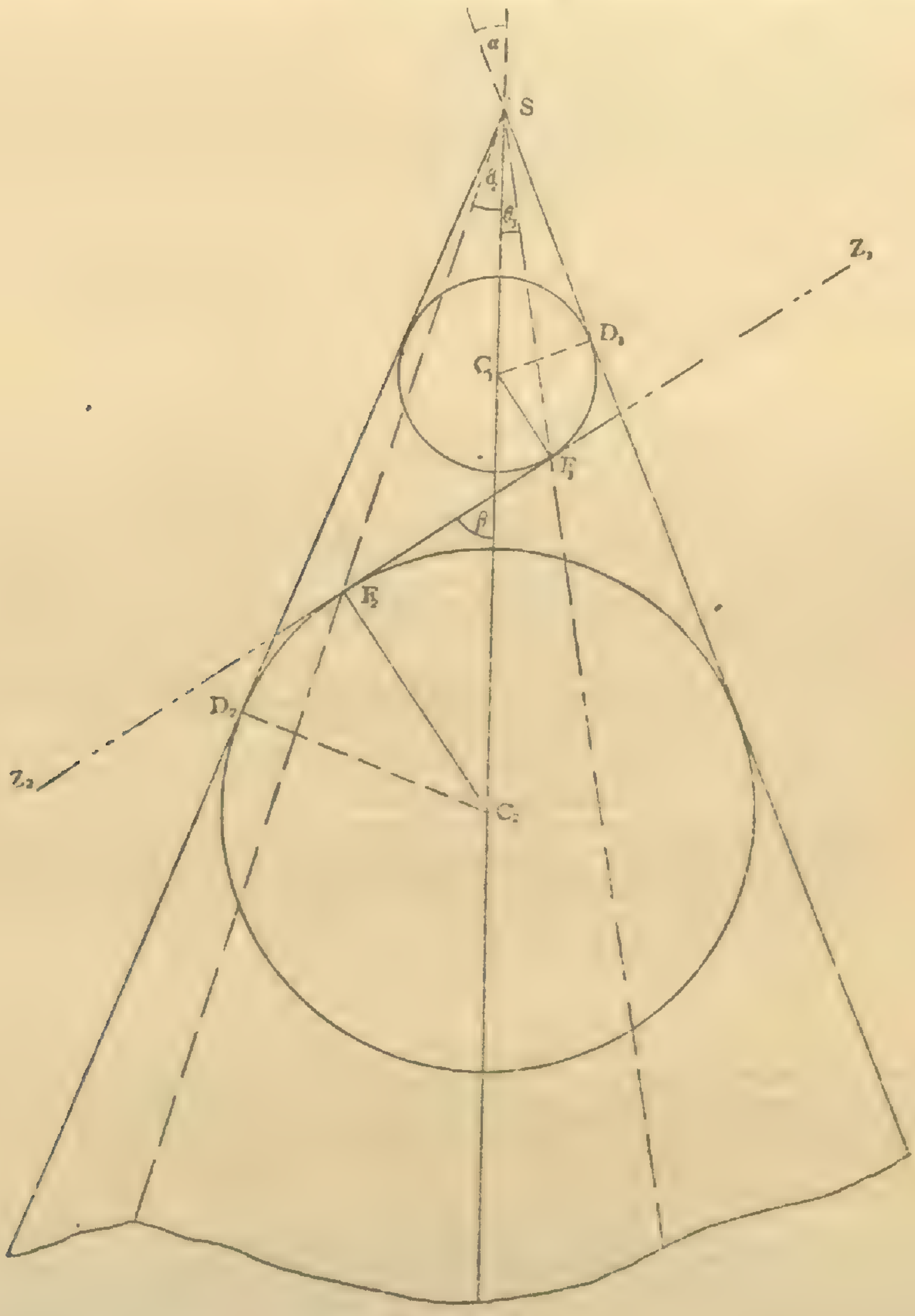

FIGURE 1.

meridian section; Z_1Z_2 represents a plane perpendicular to the meridian section; C_1 and C_2 are the centers of spheres

* Read before the New York Mathematical Society, March 5, 1892, and before The Academy of Science of St. Louis, March 21, 1892.

inscribed in the cone and tangent to the plane Z_1Z_2; F_1 and F_2 are the foci * of the section cut from the cone by the plane Z_1Z_2. Join SF_1, SF_2, C_1F_1, C_2F_2, C_1D_1, C_2D_2.

Let

$\alpha \equiv$ half the angle at the vertex of the cone.
$\beta \equiv$ the angle which the plane Z_1Z_2 makes with the axis of the cone.
$\theta_1 \equiv$ the angle C_1SF_1.
$\theta_2 \equiv$ the angle C_2SF_2.

Then

$$\angle SF_1F_2 = 180° - (\beta + \theta_1)$$
$$\angle SF_2F_1 = \beta - \theta_2.$$
$$\angle SF_1C_1 = 90° - (\beta + \theta_1)$$
$$\angle SF_2C_2 = 90° + (\beta - \theta_2)$$

In the triangle SF_1C_1,

$$\frac{\sin \theta_1}{\cos (\beta + \theta_1)} = \frac{C_1F_1}{C_1S} = \sin \alpha$$

whence

$$\sin \theta_1 = \sin \alpha \cos (\beta + \theta_1)$$
$$= \sin \alpha (\cos \beta \cos \theta_1 - \sin \beta \sin \theta_1)$$

and

$$\tan \theta_1 = \frac{\sin \alpha \cos \beta}{1 + \sin \alpha \sin \beta} \qquad (1)$$

Similarly, in the triangle SF_2C_2,

$$\frac{\sin \theta_2}{\cos (\beta - \theta_2)} = \frac{C_2F_2}{C_2S} = \sin \alpha$$

whence

$$\sin \theta_2 = \sin \alpha \cos (\beta - \theta_2)$$
$$= \sin \alpha (\cos \beta \cos \theta_2 + \sin \beta \sin \theta_2)$$

and

$$\tan \theta_2 = \frac{\sin \alpha \cos \beta}{1 - \sin \alpha \sin \beta} \qquad (2)$$

* Salmon, "Conic Sections," 6th Ed., Sec. 367.

Inspection of equations (1) and (2) shows that the values of θ_1 and θ_2 depend only on the values of α and β, and that, for a given cone, if β is a constant, θ_1 and θ_2 are constants; or, the locus of the foci of similar sections consists of two cones of revolution whose axes coincide with the axis of the original cone and whose angles at the vertex are given by equations (1) and (2) respectively; and the locus of the foci

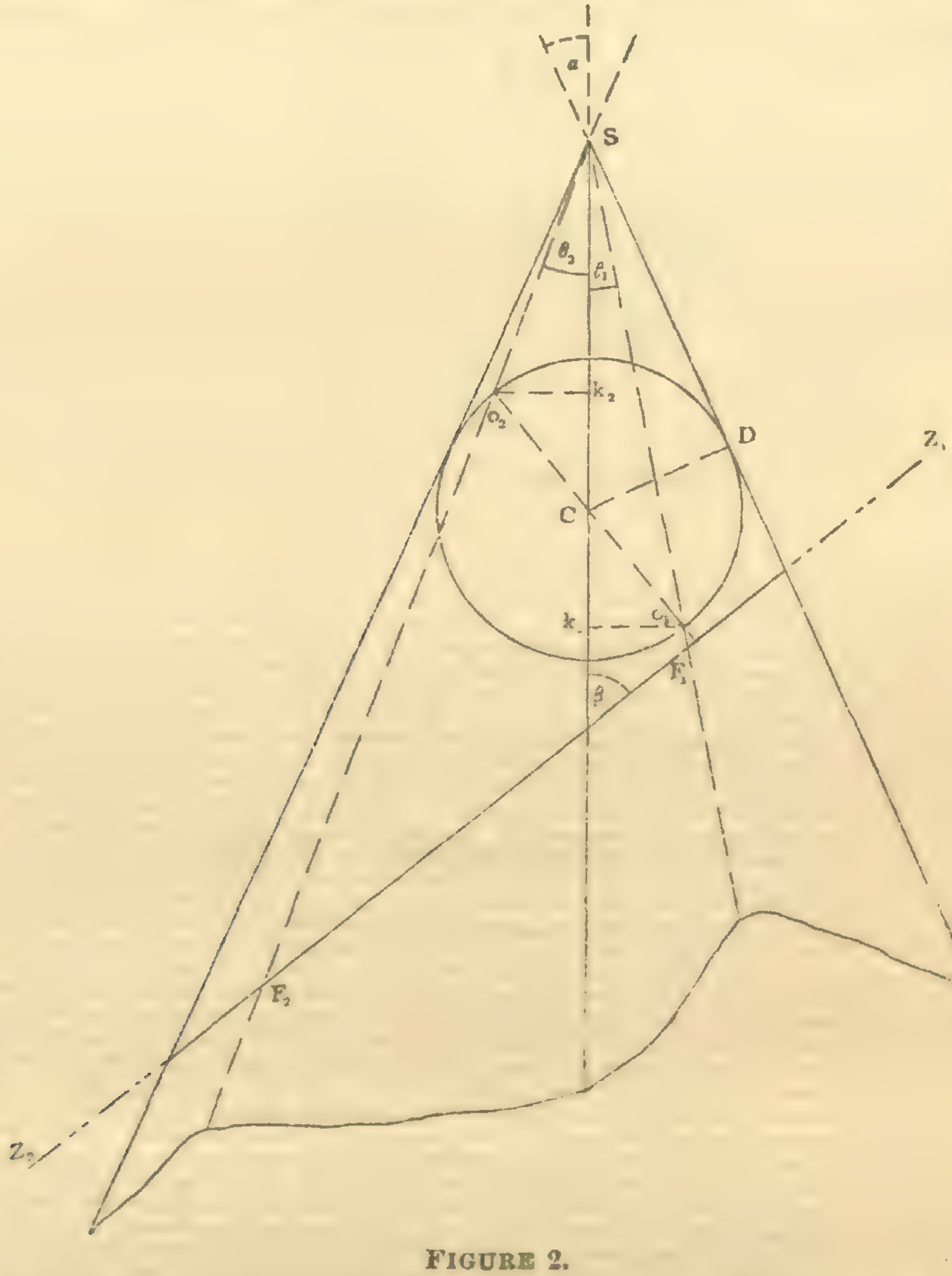

FIGURE 2.

of parallel sections consists of two straight lines (SF_1 and SF_2 in Fig. 1) whose angles with the axis are given by equations (1) and (2) respectively.

The following construction derived from equations (1) and (2) is identical for the cases of the *ellipse* (Fig. 2), the *parabola* (Fig. 3), and the *hyperbola* (Fig. 4); and as corresponding points have the same letters in all these figures, the following explanation applies to all three.

With any point, C, on the axis of the cone, as a center, inscribe a sphere, radius CD; its intersection with the plane of the paper will be a circle as in the figure. From the center C draw a perpendicular to the plane of the section, which in the figure is the line Co_1 drawn perpendicular to Z_1Z_2. This line cuts the circle in two points, o_1 and o_2. The lines So_1 and So_2, joining these points, respectively, with the vertex, cut the plane of the section Z_1Z_2 in the points F_1 and F_2, respectively, which are the foci of the section.

For, from the figure,

$$Co_1 = CD = \text{the radius} = r = SC \sin \alpha$$

and

$$\angle\ Co_1k_1 = \beta$$

$$o_1k_1 = r \cos \beta = SC \sin \alpha \cos \beta$$

$$Ck_1 = r \sin \beta = SC \sin \alpha \sin \beta = Ck_2$$

$$Sk_1 = SC + Ck_1 = SC + SC \sin \alpha \sin \beta$$

$$= SC\ (1 + \sin \alpha \sin \beta)$$

$$Sk_2 = SC - Ck_2 = SC - SC \sin \alpha \sin \beta$$

$$= SC\ (1 - \sin \alpha \sin \beta)$$

wherefore

$$\tan\ \theta_1 = \frac{o_1k_1}{Sk_1} = \frac{SC \sin \alpha \cos \beta}{SC\ (1 + \sin\ \alpha \sin \beta)}$$

$$= \frac{\sin \alpha \cos \beta}{1 + \sin\ \alpha \sin \beta}$$

and

$$\tan\ \theta_2 = \frac{o_2k_2}{Sk_2} = \frac{SC \sin \alpha \cos \beta}{SC\ (1 - \sin \alpha \sin \beta)}$$

$$= \frac{\sin \alpha \cos \beta}{1 - \sin \alpha \sin \beta}$$

or, by (1) and (2) the lines So_1 and So_2 are the elements of the focal cones for all sections parallel to that cut by the plane Z_1Z_2 and their intersections with Z_1Z_2 give the foci for that section.

The correctness of the above construction is also evident from the consideration that the points o_1 and o_2 are the points of contact with the sphere of planes parallel to Z_1Z_2 and are therefore points on the focal cone.

FIGURE 3.

In Fig. 3, where Z_1Z_2 is taken parallel to an element of the cone so that the section is a *parabola*, the focus which is at an infinite distance is obtained from the construction by observing that the point o_2 falls on that element of the original cone to which the plane Z_1Z_2 is parallel, and that therefore F_2,

being at the intersection of this element with the plane, is at infinity.

In Fig. 4, where Z_1Z_2 is taken so as to cut a *hyperbola* from the cone, the focus F_2 is obtained by producing the line So_2 in the opposite direction till it intersects Z_1Z_2.

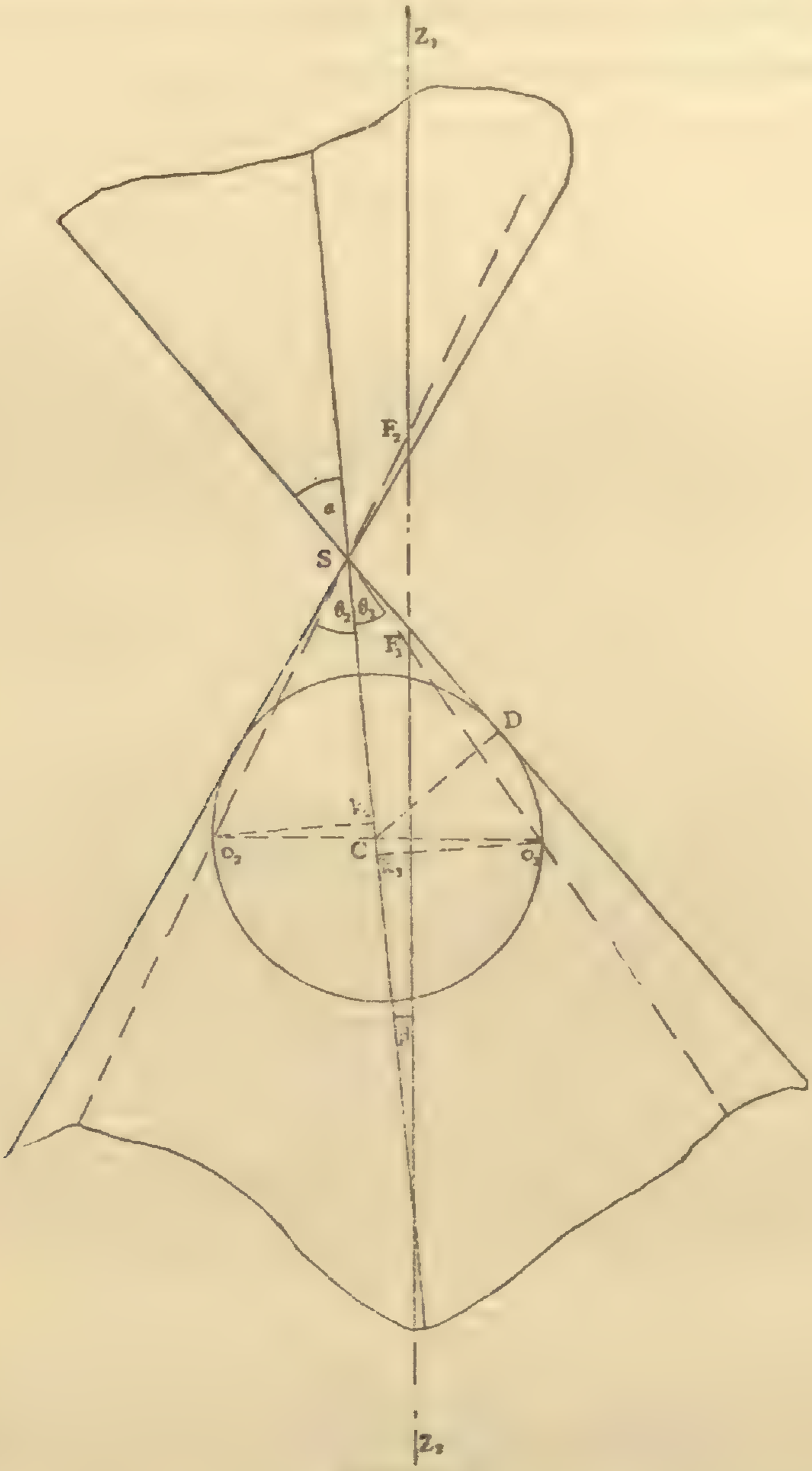

FIGURE 4.

When the plane of the section is parallel to the axis, the construction becomes even simpler; for then

$$\beta = 0^\circ,$$

and

$$\tan \theta_1 = \tan \theta_2 = \sin \alpha$$

In Fig. 5, with the vertex, S, as a center and any radius, describe an arc cutting the elements of the cone (SD_1 and SD_2) in o_1 and o_2 respectively. Draw $o_1 k$, $o_2 k$, perpendicular to the axis, and $o_1 q_1$, and $o_2 q_2$ parallel to the axis, meeting

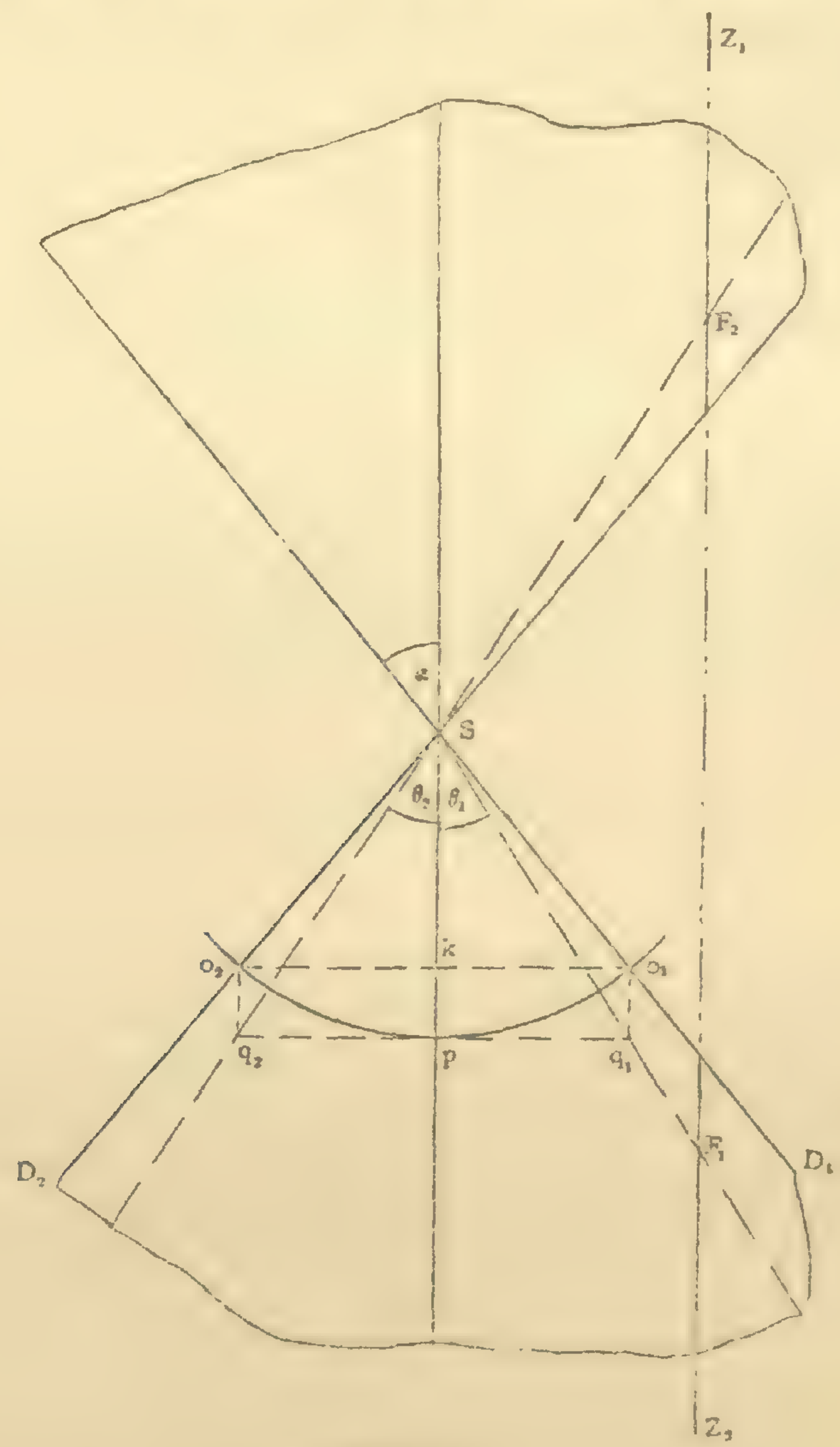

FIGURE 5.

the tangent at p in q_1 and q_2 respectively. Join Sq_1 and Sq_2. If the radius taken is considered unity,

$$o_1 k = p\ q_1 = \sin \alpha = \tan \angle\ p\ Sq_1$$

$$= \tan \theta_1$$

and

$$o_2 k = p\ q_2 = \sin \alpha = \tan \angle\ p\ Sq_2$$

$$= \tan \theta_2$$

Therefore, Sq_1 and Sq_2 are elements of the focal cones for the section $Z_1 Z_2$, and F_1 and F_2 are the foci of that section.

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VOL. VI. No. 3.

THE MAPPING OF MISSOURI.

BY

ARTHUR WINSLOW,
Assisted by C. F. Marbut.

Issued September 23, 1892.

THE MAPPING OF MISSOURI.

By Arthur Winslow,

Assisted by C. F. Marbut.

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If the use of so trite an analogy is permissible, it is safe to say that, at this period of the world's history, the civilization of a people is closely proportional to the degree to which the country in which they live is accurately mapped. During periods of barbaric habitation, or during early settlement by more civilized foreigners only the rudest diagrams, if any, are made; such are sufficient to satisfy the simple needs of the

time. As civilization grows or as the civilized population increases, wider knowledge of the geography and better maps become necessary to meet the needs of new settlement or of commerce; and, when population becomes dense, better and better maps are constantly demanded to answer the requirements of a great traffic, for purposes of construction and improvement and for the exact establishment of property lines which the enhanced value of real estate calls for. Hence, the mapping of an area is necessarily a progressive work; there is an evolution of cartography as of other objects, natural and cultural. The earliest charts are the products of exploration; rudé sketches showing mere outlines and these defined with only a slight approach to accuracy. A few astronomically determined points, roughly determined at that, constitute the principal data as to location, supplemented, perhaps, by a meander line run down some river, in a boat, with hand compass bearings and estimated distances. As other explorations are made additional points are determined, lines of travel are meandered out, corrections are made of errors in former locations and, by degrees, a fairly reliable diagram of the area is produced. As the country becomes populated, surveys for political divisions and for cadastral divisions are inaugurated and, from these, additional facts are collected. Finally, and it is deplorable that it should seemingly be necessarily at so late a stage, triangulation is extended over the area, topographic mapping is prosecuted and detailed maps of various kinds to suit the different needs are produced. In nearly all civilized countries detailed and accurate maps are now constructed of different portions, but it would be hazardous to assert, at present, that of any one area the final map has been produced.

Missouri has had, like other countries, her succession of explorations and surveys and resultant maps, but she is still far from having reached the final stage. It is the purpose of this article to display the status of such work at the present time, to briefly sketch the history of mapping as affecting Missouri and to indicate the probable lines of future growth.

The first maps including the area of Missouri are necessarily those rough diagrams of the early explorers which repre-

sented the continent of America. Their relations to Missouri cartography are, of course, only of a general nature; but it is thought that they are of sufficient historic interest to justify a description of some of the more important ones here.

Rough attempts at the mapping of America began almost with its discovery and we find the general outlines of the continent suggested in charts dating back as far as the beginning of the 16th century.

The map accompanying the edition of Ptolomæus of 1508, edited in Rome, is credited with being the most complete and reliable extant of what was then known in regard to America.* The title of the map translated is, "A more universal table of the known world compiled from modern observations." It contains, of North America, little more than a rough and generalized outline of the eastern coast as far south as Florida.

Columbus had entered the Gulf of Mexico but only explored its southern coast. The "Admiral's map" in the Ptolemy, edition of 1513, shows a delta of a river corresponding in position to that of the Mississippi; but this must have been from conjecture, as it was not until 1518 that the northern coast was completely explored by Garay, who reached the Mississippi river and gave to that stream the name *Rio del Espiritu Santo* (River of the Holy Ghost).†

A Globe in Frankfort on the Main, in the city library, is credited to the year 1515 or 1520, and is supposed to have been made by J. Schœner, whose globe of the latter year preserved in Nuremburg agrees with this in all its principal features.‡ This map represents the North American continent

* A reduced copy of this map is contained in Vol. I opposite p. 499 of Lieut. Wheeler's Reports of the United States Geographical Surveys West of 100th Meridian.

† French's Historical Collections of Louisiana, Vol. IV, p. VII.

Winsor, in Vol. II of his Narrative and Critical History of America, on p. 218, gives a sketch of a map of the date 1520, which he states was sent to Spain by Garay, the Governor of Jamacia. It shows what seems to be the mouth of the Mississippi under the name "Rio del Espiritu Santo." Winsor characterizes it as a "surprisingly accurate draft of the shores of the Gulf."

‡ A reduced copy of a part of this map is contained in Vol. I, of the Reports of the U. S. Geog. Surveys west of 100th Merid., opposite p. 501.

as an island of rough triangular shape. It contains some few details of the eastern coast, but these cannot be assigned to details now outlined. This is notable as being considered the first upon which the name "America" appears. In the Ribero map of 1529, the Cabot map of 1544, and in others of about the same date the Gulf of Mexico is outlined as in the Garay map referred to.*

The Zaltieri map was engraved in Venice in the year 1566,

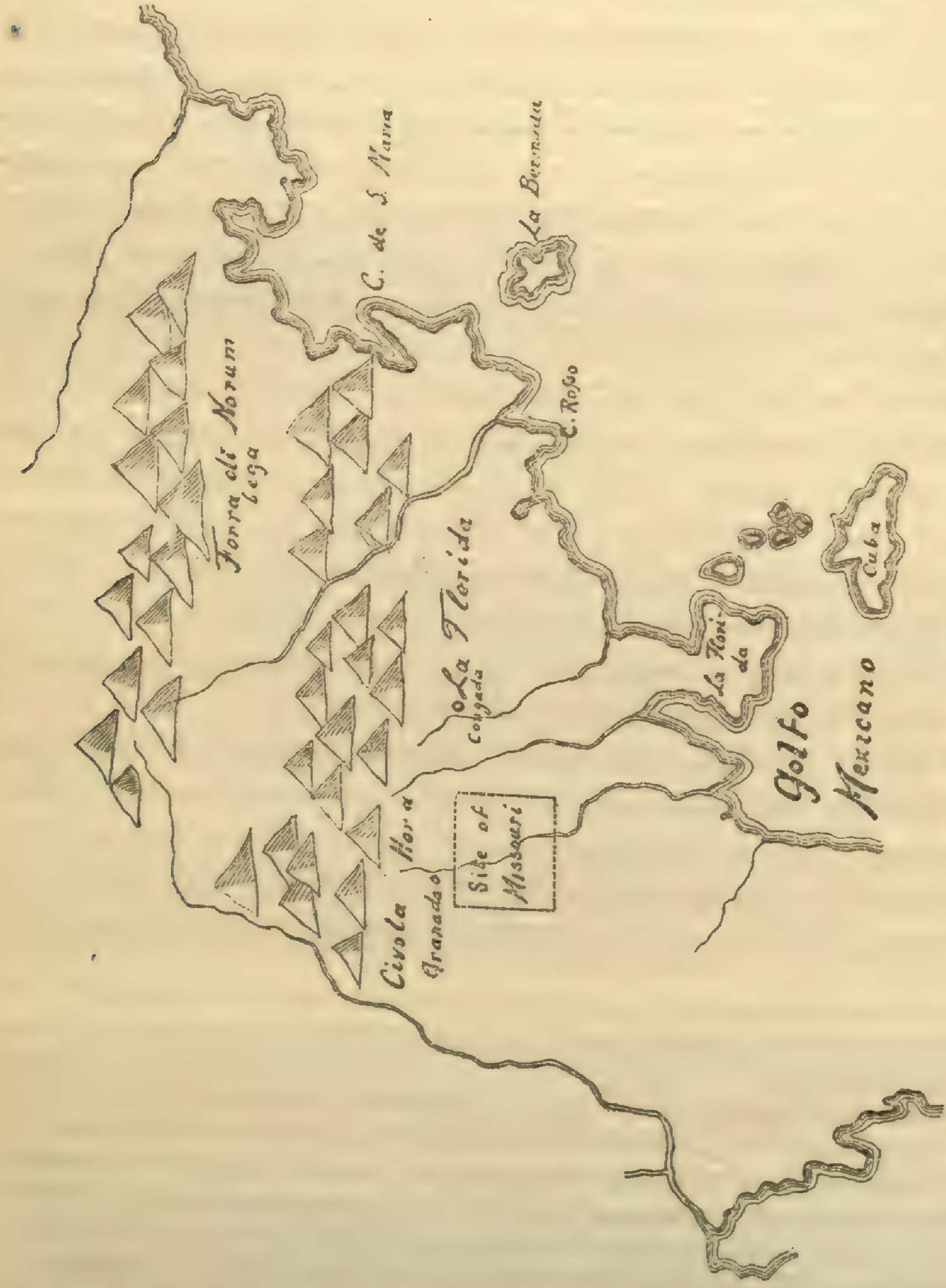

FIG. 1. ZALTIERI MAP — 1566.

* For sketches of these, see Winsor's Nar. and Crit. Hist., Vol. II, pp. 218 to 229.

by Bolognino Zaltieri. A printed copy is preserved in the imperial library in Paris. A sketch of a portion of a reduced copy of this map contained in Vol. I, of the 100th Merid. reports opposite p. 504, is presented here.

The name Gulf of Mexico, it will be noted is applied here, as is also the name Florida to the peninsular which now bears that name. Two large streams also enter the Gulf from the north, one of which may have been intended to represent the Mississippi, perhaps inserted from the results of the De Soto expedition earlier in the century. The mountain ranges indicated it is hard to find a place for in our modern topographic maps of the country. The approximate site of Missouri is added to this map for the purpose of the present article.

FIG. 2. MERCATOR MAP — 1569.

The Mercator (Girard) "mappemonde" of 1569, introduced his well-known projection. An enlarged copy of an outline sketch of a portion of this map relating to North America, is introduced above. It will be noticed that the Gulf of Mexico is represented much more accurately than in the earlier map of Zaltieri. The extension of the St. Lawrence river into the southwestern portion of the continent is a noticeable feature which we find reproduced in others which

succeed it. The existence of any great stream flowing into the Gulf, such as the Mississippi, is not even suggested.

The Ortelеus map was first issued in 1570, in Antwerp. This resembles the Mercator map in the essentials, and a similar projection is used.*

The Hondius (Jodocus) map of 1609 was also based largely upon the Mercator map. Hondius was a celebrated Dutch geographer who was associated with Mercator. The whole western hemisphere is represented upon his map and the Gulf of Mexico is fairly well outlined. The St. Lawrence is extended far into the interior. Some other details of interior drainage and distribution of mountains are also given.†

FIG. 3. DE WIT MAP — 1670.
Initial Merid., presumably at Ferro Island.

The De Wit map, prepared about the year 1670, shows the

* For a sketch of this map see Nar. and Crit. Hist. Vol. IV, p. 95 and for further references see Reports U. S. Geog. Surveys West 100th Merid. Vol. I, p. 503.

† 100th Merid. Reports, Vol. I, p. 506.

whole northern half of the continent. A sketch of a portion is presented here. The Gulf is quite accurately shown. The St. Lawrence is no longer extended so far inland. The presence of the Mississippi would seem to be suggested by the estuary-like mouth of an arborescent drainage system, but its mouth is actually located under the name *R. de Spiritu Santo*, near the northwestern corner of the peninsula of Florida.

In 1672–73 an anonymous map appeared representing the course of the Mississippi from the Lakes to the Gulf.* It is, however, considered spurious; it was probably prepared by the Jesuits and was in advance of the appearance of the results of Joliet's and Marquette's exploration.†

The Joliet map of 1673–74 seems, says Winsor, to have been made by Joliet immediately after his return to Montreal from his expedition down the Mississippi in the summer of 1673 with Marquette. A copy of a sketch of this map is reproduced on the next page. This is considered the earliest map of the Mississippi based on actual knowledge. The exploration did not extend below the mouth of the Arkansas; but, from the course of the river at that point, and from information derived from the Indians, the explorers reached the conviction that the great river emptied into the Gulf and so represented it on their map. Joliet applied the name Buade (the family name of the Governor Frontinac, to whom the map is addressed) to the Mississippi.‡ This is also the first map

* This is the map familiarly known as the Thevenot map, published in M. Thevenot's "Recueil de Voyages," in 1681. (A copy of this map is in library of the Mo. Hist. Society in St. Louis.)

† Nar. and Crit. Hist. Vol. IV., p. 220.

‡ Winsor further states in a foot note, on page 209 of Vol. IV, of his Nar. and Crit. Hist., that the Jesuit *Relations* call it the "*Grande Rivière*" and the "*Messi-sipi*," Marquette calls it "*Conception*" and in 1674 it was called after Colbert. On p. 79 of Vol. V, he states further that the original spelling of the word Mississippi in its nearest approach to the Algonquin word is *Mêché Sébè*; Tonty suggested *Miche Sepe*; Laval *Michisepe*; Labatt softened this to *Misisipi*; Marquette made it *Missisipi*; another explorer made it *Mississipi*, and it is so spelled in France at the present. The origin of the double p is not known. The river was known as the "Malbanchia" by the Indians and was termed "Palissado" by the Spaniards (*Ibid.* Vol. V, p. 18). In 1712 the name "*St. Louis*" is substituted for Mississippi in the Crozat patent and in the same document "*St. Philip*" is substituted for Missouri and "*St. Jerome*" for Ouabache (*Ibid.* Vol. V, p. 28).

which locates the Missouri river and from it we are able to designate with more exactness the site of our own State.*

Franquelin's map of 1684 entitled *Carte de la Louisiane*, is stated to embody the results of La Salle's exploration of the Mississippi, who reached the Gulf in the spring of 1682.

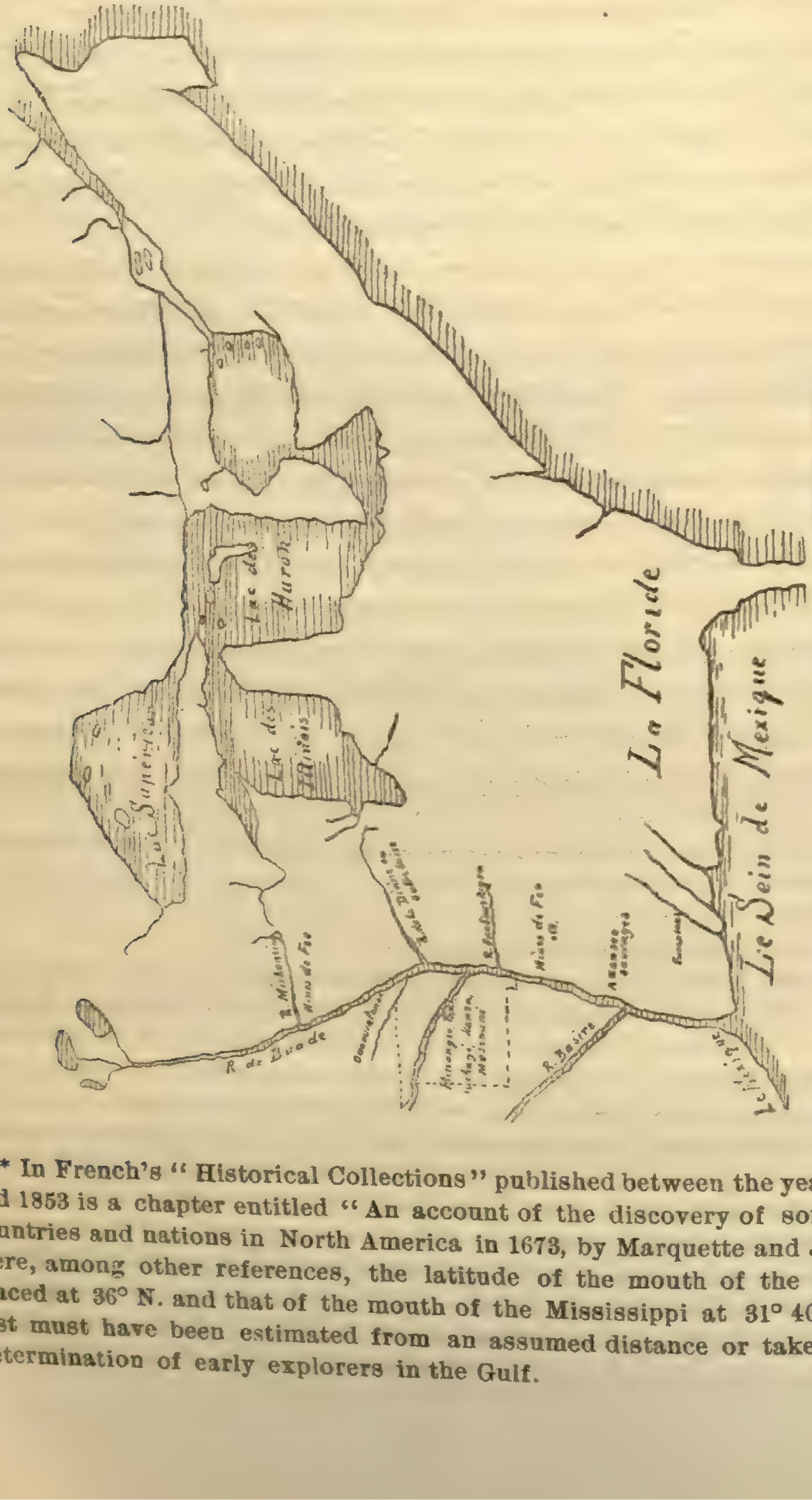

FIG. 4. JOLIET'S MAP — 1674.

* In French's "Historical Collections" published between the years 1846 and 1853 is a chapter entitled "An account of the discovery of some new countries and nations in North America in 1673, by Marquette and Joliet." Here, among other references, the latitude of the mouth of the Ohio is placed at 36° N. and that of the mouth of the Mississippi at 31° 40′. The last must have been estimated from an assumed distance or taken from determination of early explorers in the Gulf.

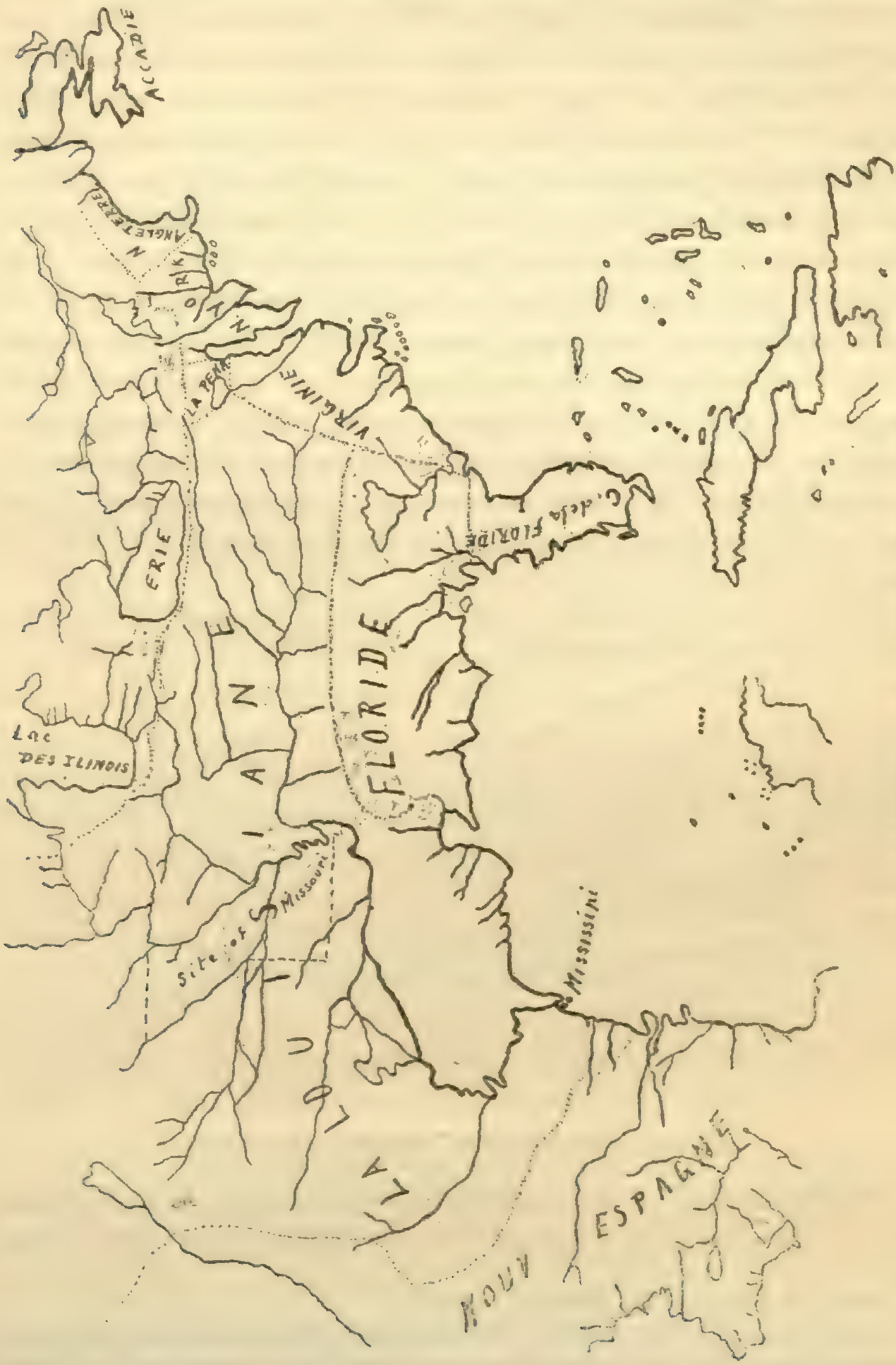

FIG. 6. FRANQUELIN'S "GREAT MAP" — 1684.

It was prepared by a young French engineer, Jean-Baptiste Louis-Franquelin, who was in Quebec in 1683, on La Salle's arrival en route for France. A copy of a sketch is introduced here from Winsor.* The name "*La Louisiane*," which was given the country by La Salle, on his reaching the mouth of the Mississippi, is applied here, as is also the name "Missisipi." The peculiar deflection of the lower course of the river and the position assigned its mouth are features difficult to understand, especially in view of the fact that the earlier Joliet map is much more true to nature in this respect. It suggests a reason for the unfortunate mistake which La Salle made, some two years later, in trying to find the mouth of the river with his colonists from France. A mistake which proved fatal to him as well as to many of his companions.† Another map of Franquelin, referred to as his "third map," is dated 1688. It contains some additional features of drainage which are shown in the accompanying sketch.

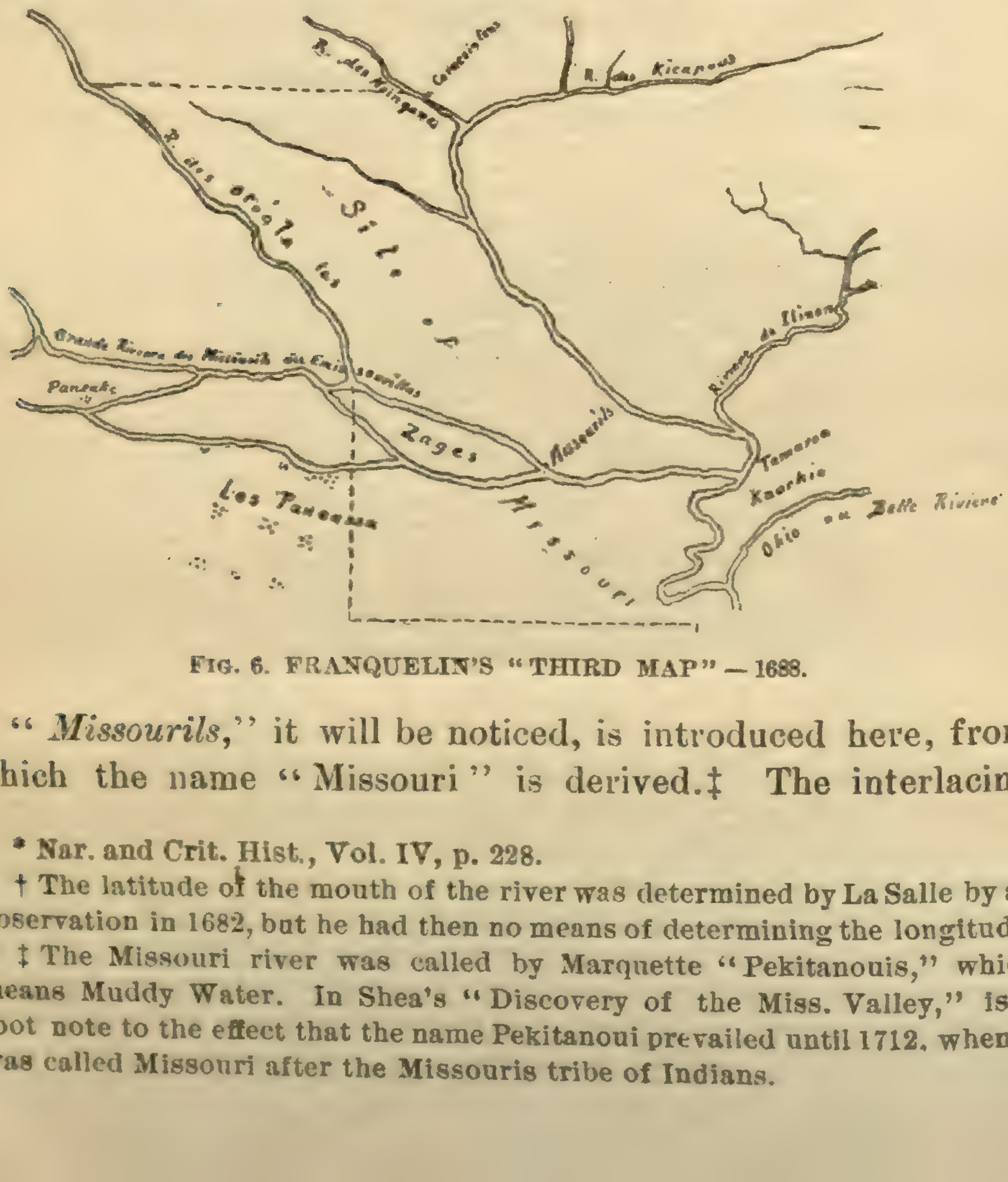

FIG. 6. FRANQUELIN'S "THIRD MAP" — 1688.

"*Missourils*," it will be noticed, is introduced here, from which the name "Missouri" is derived.‡ The interlacing

* Nar. and Crit. Hist., Vol. IV, p. 228.

† The latitude of the mouth of the river was determined by La Salle by an observation in 1682, but he had then no means of determining the longitude.

‡ The Missouri river was called by Marquette "Pekitanouis," which means Muddy Water. In Shea's "Discovery of the Miss. Valley," is a foot note to the effect that the name Pekitanoui prevailed until 1712, when it was called Missouri after the Missouris tribe of Indians.

drainage system of the river is remarkable and indicates very imperfect knowledge of the region, and peculiar conceptions concerning it. The existence of the Osage river is suggested by the first fork above the mouth of the Missouri.

Hennepin's map of 1683, in his "*Description De La Louisiane*" contains nothing additional concerning the Mississippi or the area of Missouri. The connection of the Mississippi with the Gulf is here only indicated by a dotted line, in evidence that his explorations did not extend to the Gulf.*

Later maps of Hennepin appeared in his work entitled "*Nouvelle Découverte d'un trés grand Pays*" which show an extension of the Mississippi to the Gulf; but this portion is supposed to have been stolen from the records of La Salle's expedition.

Minet's map of 1685, entitled "*Carte de La Louisiane*" was made by the engineer, Minet, on the return voyage of the ship Joly, after leaving La Salle and his colonists at Matagorda bay.† The details of the mouth of the Mississippi as found by La Salle in 1682 and those of Matagorda bay were specially drawn. The river is shown to empty into the Gulf at Matagorda bay, which was mistaken by the expedition for its mouth. The course of the stream above the mouth is similar to that shown on the Franquelin map of 1684. The name *Missouris* is applied here also to that river, and it is represented by a peculiar double channel as in the Franquelin map.

In the year 1699 the expedition under Le Moyne d'Iberville reached the mouth of the Mississippi, established a settlement there and explored the stream for a distance of 100 leagues above its mouth. From that date on the river was traveled frequently by explorers and travelers and its course became well known.

La Hontan's maps originally appeared in 1703 in his "*Nouveaux Voyages dans l'Amérique septentrionale*,"‡ etc.

* For a fac-simile of a portion of this map see Winsor's Nar. and Crit. Hist., Vol. IV, p. 249.

† For a sketch of this map see Winsors Nar. and Crit. Hist., Vol., IV, p. 287.

‡ Portions of these maps are reproduced in Nar. and Crit. Hist., Vol. IV, pp. 358 to 361.

On one of these, which is a strikingly crude production, the Ouabach, or Ohio river, is shown to empty into the Mississippi, opposite the mouth of the Missouri. This map is noteworthy as being the first one, to the writer's knowledge, on which the name Osage is applied to a tributary of the Missouri river. It is the one on which La Hontan shows his mythical "*Riviere Longue*," or "Dead River," which he claims to have explored. The lines of latitude and longitude are designated on the map, the latter being presumably east from Ferro island, as that point had been generally accepted by European mathematicians as the position of the initial meridian as much as seventy years previous. According to these lines the Mississippi river is as much as 100 miles west of its true position, and the mouth of the Missouri about 180 miles too far south.

The Delisle maps (*1703 and 1707*) are joint productions of the father and son, Claude and Guillaume Delisle.

Winsor speaks of them as the most distinguished French cartographers of the early part of the eighteenth century. Their map of the upper part of the Mississippi valley, under the title of "*Carte du Canada ou de la Nouvelle France*," * shows the Missouri river and the location of the old Fort St. Louis. The Des Moines river is shown under the name R. de Moingona. In their map of the lower part,† the Ozark mountains are faintly suggested and are labeled "*Pays plein de Mines;*" this we find reproduced in several subsequent maps and it is perhaps based upon Penicault's report of the existence of lead mines west of St. Genevieve, which information he acquired when accompanying Le Sueur's expedition up the Mississippi in the year 1700.

Sinex's (*John*) *Map of North America* was published in London in 1710. A sketch of a portion is presented on p. 69. The course of the Mississippi is much more accurately shown than on any of the previously presented maps, as is also the lower course of the Missouri. The initial point for the

* This map is reproduced in Winchell's Vol. I, p. 20, Final Report Geol. Survey of Minn.

† A reproduction of this portion of the map is contained in Winsor's Nar. and Crit. Hist, Vol. II, p. 294.

meridian lines is presumably Greenwich. On this assumption the outlines of the State are added to the sketch in fine dotted lines, while the outlines of the State with reference to topographic features are shown by the dash and dot lines.*

FIG. 7. SINEX'S MAP — 1710.
Initial Merid., presumably at Greenwich.

The Mississippi is thus shown to be located from 50 to 60 miles too far west and the mouth of the Missouri 25 miles too far north.

Edward Wells' atlas appeared in 1722, and consisted of 41 maps, of which one is a part of North America. A reduced copy of this is contained in Vol. I of the Reports of the 100th Merid. Surveys, opposite p. 511. The longitude of St. Louis is here at about 113¾° W. and the latitude at about 36½° N. If the longitudes are referred to Greenwich, which is probable, the Mississippi is assigned a position over 20 degrees west of the true one, a much greater inaccuracy than in the earlier Sinex map. The course of the Mississippi

* A reduced copy of this map is in Vol. I, opposite p. 510 of Reports U. S. Geog. Surveys west of 100th Merid., and the annexed sketch is from this.

river is also very crudely shown. The presence of the Ozark mountains seems to be suggested, but the range is continued eastward on the original map and south of the Illinois lake it is termed the "Apalachin M."

In 1733 an edition of a map by Henry Popple was issued, entitled "A Map of the British Empire in America, with the French and Spanish settlements adjacent thereto." * It is in atlas form, the maps being in large colored sheets on a scale of about 50 miles to the inch. The Mississippi and Missouri rivers and their tributaries are shown, but very inaccurately.

D'Anville's map of 1752, entitled "*Carte de la Louisiane*," has only the lower Mississippi valley represented.†

Dumont's map of 1753, also named "*Carte de la Louisiane*," was published in Dumont de Montigny's "*Memoires historiques de la Louisiane.*" It represents the Mississippi valley and adjacent country; lines of latitude and longitude are fixed on the map and, according to these, the longitude of the site of St. Louis is 284° E. (presumably of Ferro), which is about 94° W. of Greenwich.‡

The Du Pratz map of 1763 appears in the "History of Louisiana, by M. Le Page Du Pratz." The Mississippi river is placed about 150 miles west of the true position and the mouth of the Missouri about 70 miles too far north. On p. 295 of Vol. I, the author remarks that the French had penetrated only about "300 leagues" up the Missouri at that time.

In the year 1770, there was published in London, a work entitled "The Present State of the European Settlements on the Mississippi, with a Geographical Description of that River; illustrated by 8 plans and draughts: 4 to. By Capt. Philip Pittman." Of these draughts one entitled "Draughts of the Mississippi river from Balise to Fort Chartres," in three sheets, is of special interest here. His maps were the outcome of five years of surveys, and, from the published references,

* A copy of this map is the property of Capt. Carl F. Palfrey, Secretary of the Mississippi River Commission, of St. Louis.

† A copy of this map is in the library of the Mo. Hist. Soc., St. Louis.

‡ A copy of this map is also contained in the library of the Mo. Hist. Society.

they must be far in advance of anything preceding in their representation of the river. The writer was unable to find the volume in the accessible libraries, and, hence, is unable to present a sketch of the map here.*

In the year 1765, Lieut. Ross of the British army made a survey of the lower Mississippi river, and, in 1775, his map was published on a scale of about 14 miles to the inch, under the title of "A Map of the Mississippi River, from Balise to Fort Chartres. Taken on an expedition to the Illinois in 1765, by Lieut. Ross of the Thirty-fourth Regiment. Published 1775, London, for Robt. Sayres." The sketch on the next page is from a copy of this map in the Mo. Hist. Soc. library. This is a very interesting map and exhibits a great advance in the cartography of the river. The main sinuousities of the river are quite true to nature and are in accord with maps of recent date.† The latitude of the mouth of the Ohio river is shown to be a few minutes less than 37 dėgrees, which is closely in accord with recent determinations, which make it exactly 37 degrees. The longitude of New Orleans, shown on the map, is, however, about 50 miles east of what it should be. The note, west of the river, of, "A country abounding in mines," suggests a translation of the "*Pays plein de Mines*" on the Delisle map of 1707.

Faden's Atlas of 1777, is entitled "The North American Atlas. Printed for William Faden, Geographer to the King, MDCCLXXVII." ‡ The scale of the maps is about 80 miles to the inch. It shows the Mississippi and Missouri rivers, and some of their tributaries. Nothing in advance of the other maps described was noted, however.

Thomas Jeffery's American Atlas was published in London

* Mr. Oscar Collet, librarian of the Mo. Historical Society, states that there is a copy of this work in the library of the Illinois Hist. Soc. at Springfield, and another in the possession of Mr. H. H. Beckwith of Danville, Ill.

† A careful comparison of this map with the recent charts of the Mississippi River Commission, made by Capt. Palfrey, confirms this statement and shows that the course as delineated by Ross occupies, in some places, the lakes and sloughs of the present alluvial plain.

‡ A copy of this atlas, belonging to Capt. C. F. Palfrey, was inspected by the writer.

FIG. 8. LIEUT. ROSS'S MAP — 1765 TO 1775.

in 1775. A reduced copy of portions of his map of North America is contained in Vol. I of the 100th Merid. Reports, opposite p. 512. It contains little detail of interest here. The general course of the Mississippi river adjacent to Missouri is fairly well shown, though the stream is located about 100 miles too far west. The latitudes of the mouths of the Ohio and of the Missouri are approximately correct.

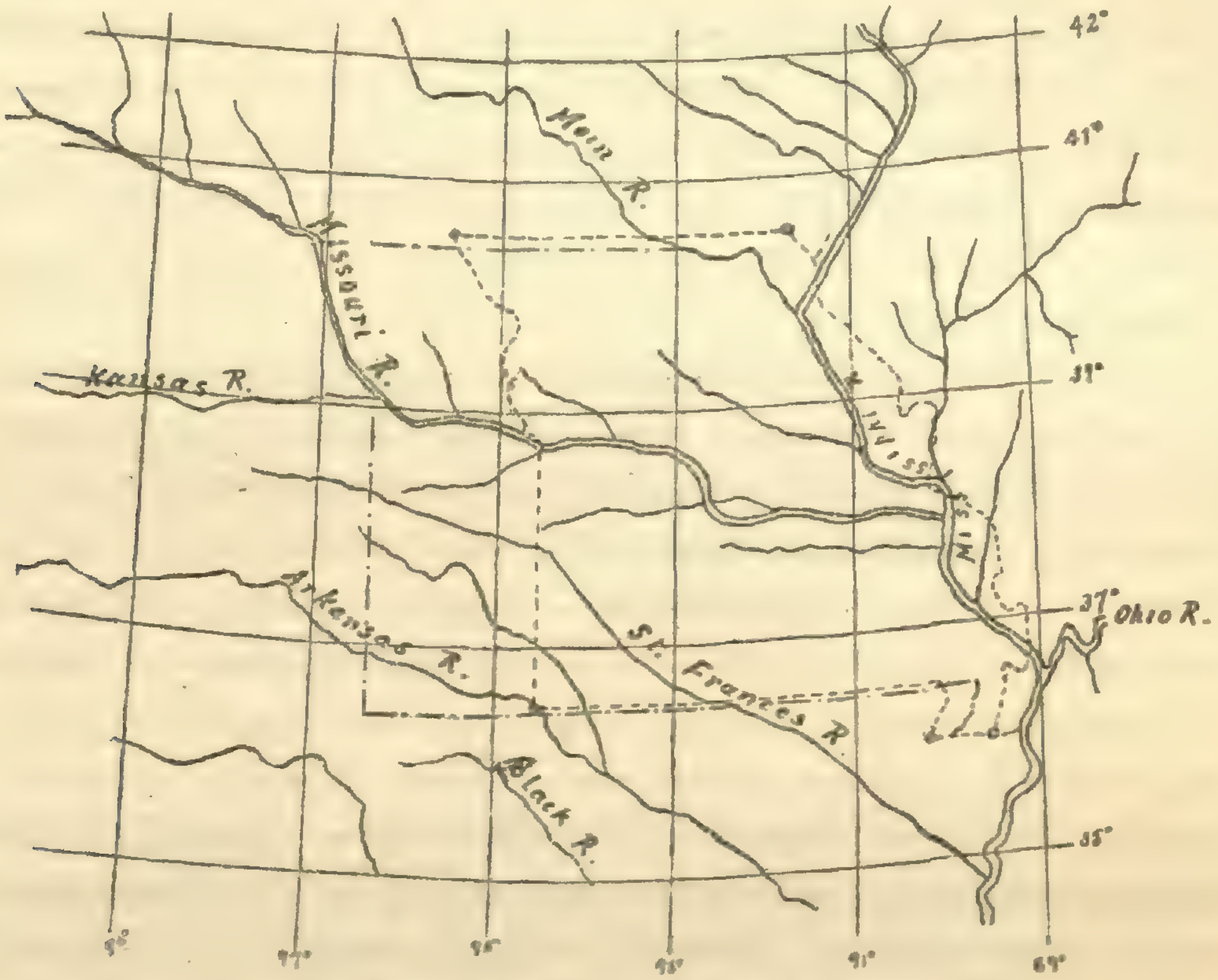

FIG. 9. WINTERBOTHAM'S MAP — 1795.
Initial Merid., presumably at Greenwich.

In Winterbotham's History of 1795, published in New York, is a map of which Lieut. Warren, in the report of the United States Pacific Railway Surveys,* introduces a reduced copy as exhibiting the knowledge possessed of the territory west of the Mississippi, before the Lewis and Clarke exploration of 1803–1806. A sketch is shown here of a portion of this map relating to Missouri and adjacent country. The courses of the Mississippi and Missouri rivers within the State approximate the locations as known to-day. The longitude of the former stream is at points nearly correct, and in this respect the map is much in advance of the others preceding it.

* Vol. XI, p. 16.

The mouths of both the Missouri and Ohio rivers are too far south, the former over 30 miles, the latter over 15. The drainage of the southwestern portion of the State is particularly inaccurate, the headwaters of the St. Francois river reaching nearly to the site of Kansas City, and the Arkansas river flowing across the southwestern corner of the State.

Arrowsmith's map was published in 1796 and with additions about 1802. It is entitled "A Map of the United States of North America, by A. Arrowsmith." The scale is about 25 miles to the inch. It includes the area of Missouri, but no especially noteworthy features are observed on it.* The course of the Mississippi river corresponds closely with that of the Ross map.

In the years 1795 and 1796, according to a claim recorded in the American State Papers,† James Mackay made a voyage of discovery "to the upper and unknown parts of Missouri," under commission from the Governor of the Provinces, Baron de Carondelet. He is credited with having made a map, as the result of his voyage, which, it is stated, is "such as never appeared before of this unknown part of the world." It was delivered to Don Manuel Gayoso de Lemos, Governor General of the Provinces. No copy of this map was accessible to the writer, and it is doubtful whether one is now extant. Exactly what is meant by the term "Missouri," is not stated. If it relates to the Missouri river this map can probably be put down as the first constructed from actual exploration of that stream.

In works published shortly after this date, maps of this part of the country are frequent. Among these may be noticed the following:—

Gilbert Imley's map of 1797, published in his "Topographical Description of the Western Territories." The site of St. Louis is placed on this map at about lat. 30½° N. and long. 92° W. of London.

L. Colin's map of 1798, accompanies the "*Voyage á la Louisiane*," etc., in 1794 to 1798, by Baudry des Lozieres.

* A copy of this map is also the property of Capt. Carl F. Palfrey.
† Public Lands, Vol. VI, p. 718.

The longitude of St. Louis is about 93° W. from Paris ($90\frac{2}{3}$° W. from Greenwich).

The Duvallon map of 1802, is in the "*Vue de la Colonie Espagnole du Mississipi*," etc., 1802, B. Duvallon, editor and author. The longitude of St. Louis is placed at $74\frac{1}{2}$° W. of *Isle de Fer* ($92\frac{1}{2}$° W. of Greenwich).

The Lewis and Clarke expedition from St. Louis to the Pacific coast was conducted during the years 1804 to 1807. This may be considered the first definitely recorded survey of the Missouri river. The expedition started at St. Louis and proceeded up the Missouri river in keel boats. The explorers were provided with compasses, chronometers, sextants and artificial horizons.

Various editions of the resultant reports were published. Three of these have been consulted by the writer. The first was issued in London in 1809, under this title: "The Travels of Capts. Lewis and Clarke from St. Louis by way of the Missouri and Columbia Rivers to the Pacific Ocean performed in the years 1804, 1805 & 1806 by order of the Government of the United States containing," etc. "Compiled from various Authentic Sources and Original Documents," etc. — "Illustrated with a map of the country in-

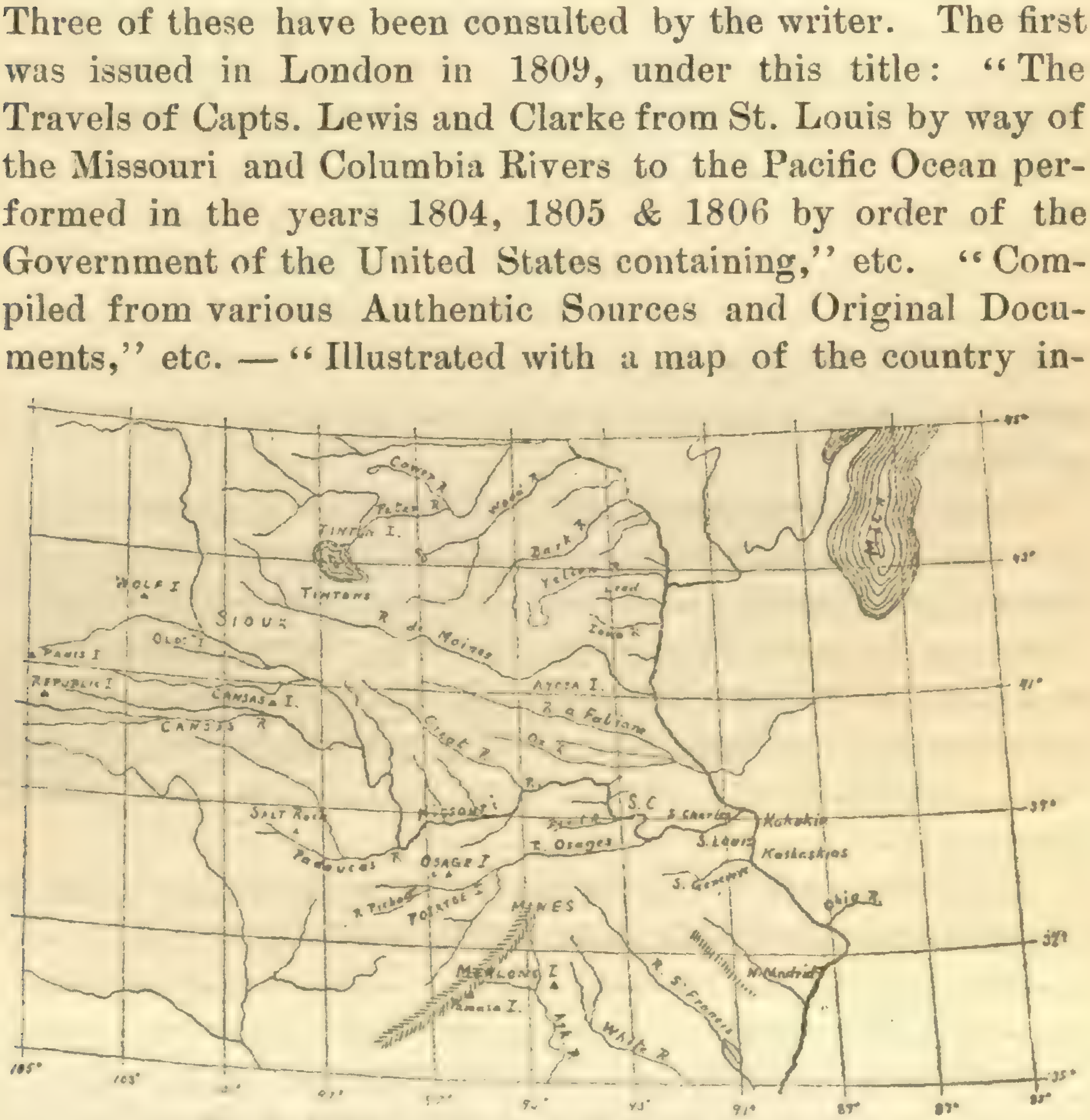

FIG. 10. LEWIS AND CLARKE MAP — 1804 TO 1806.
Edition of 1809.
Initial Merid., at Greenwich.

habited by the Western Tribes of Indians. London. Printed for Longman, Hurst, Rees and Orme, Paternoster Row — 1809." A reproduction of the map accompanying this edition is inserted on p. 75. In the report the Missouri river is said to be about five leagues above St. Louis, at latitude about 40° N. The position thus assigned the river does not agree with that shown on the map, as a casual inspection will show, nor is it in accordance with the position of cited in later editions. The map is, however, a very crude production. The mouth of what is termed the "Causas river" is placed at about 98° 30′ W., whereas it should be 94° 30′ W., and it is further located about 450 miles west of St. Louis, whereas it is actually only about 240 miles west. This and other features of the map lead one to believe that it was hastily prepared and does not really incorporate the results of the expedition.

In an edition entitled "History of the Expedition under the command of Captains Lewis and Clarke to the Sources of the Missouri," etc., prepared for the press by Paul Allen, Esq., Philadelphia, 1814," the location of the mouth of the Wood river, opposite the mouth of the Missouri river, is given, on p. 3, as 38° 55′ $19\frac{6}{10}$″ N. lat. and 89° 57′ 45″ west of Greenwich, which is about ten miles east of its true position and about five miles north.

The third edition is entitled: "Travels to the Source of the Missouri river and Across the American Continent to the Pacific Ocean, performed by Order of the Government of the United States in the years 1804, 1805 and 1806. By Captains Lewis and Clarke, published from the official report and illustrated by a map of the route and other maps. London. Printed for Longman, Hurst, Rees, Orme and Brown, Paternoster Row, 1814."

The latitude and longitude of the Missouri river, as given in this edition, agrees with that of the Allen edition. The map accompanying this volume is a great improvement over that of the earlier report. The course of the Missouri river is quite accurately shown and, according to the report, was laid down from courses and distances taken in the up passage, corrected by frequent observations of latitude and longitude.

The mouth of the Kansas river is only about ten miles too far east. The tributaries Gasconade, Osage, "Two Charaturns," and Grande rivers are located. From the detail shown of the Osage river, the results of the later Pike expedition hereinafter described, are undoubtedly incorporated in this map.*

The Pike Expedition was conducted during the years 1805–1807. The results were published under the title of "Account of Expeditions to the Sources of the Mississippi and through the Western Parts of Louisiana, to the Sources of the Arkansas, Kans., La Platte and Piere Juan rivers, etc., by Maj. Z. M. Pike." This edition was issued in 1810 by Conrad of Philadelphia, accompanied by large maps. Another edition was issued in 1811 by Longman, Hurst, Rees, Orme and Brown of London, accompanied by quite small maps, entitled: "Exploratory Travels through the Western Territories of North America," etc.

The expedition proceeded up the Mississippi river from St. Louis, noting the course of the stream during their progress. Astronomical observations were also taken. On the map accompanying the London edition, the position of the channel of the Mississippi is fairly well shown. The position of the mouth of the Missouri is taken from Captain Lewis's determinations and is the same as that published in the Philadelphia edition of 1814, of the Lewis and Clarke report. The mouth of the Des Moines river is about in the correct position.

In 1806 Maj. Pike returned to St. Louis and conducted an exploration up the Missouri and Osage rivers; the instruments carried were a sextant, chronometer and compasses. From this expedition there resulted what we may term the first map of the Osage river. The sketch on the next page displays the results as expressed in the map accompanying the Philadelphia edition of the report. The remarkable meanders of this stream are shown, though not to a great degree of accuracy. The Mississippi is also fairly well shown, though not so well as on Ross's map of 1775. The drainage of the Ozark region is very imperfectly represented.

* The report of the Pike expedition was published by the same firm in 1811, and they hence had the accompanying maps at their disposal in preparing this edition of the Lewis and Clarke report.

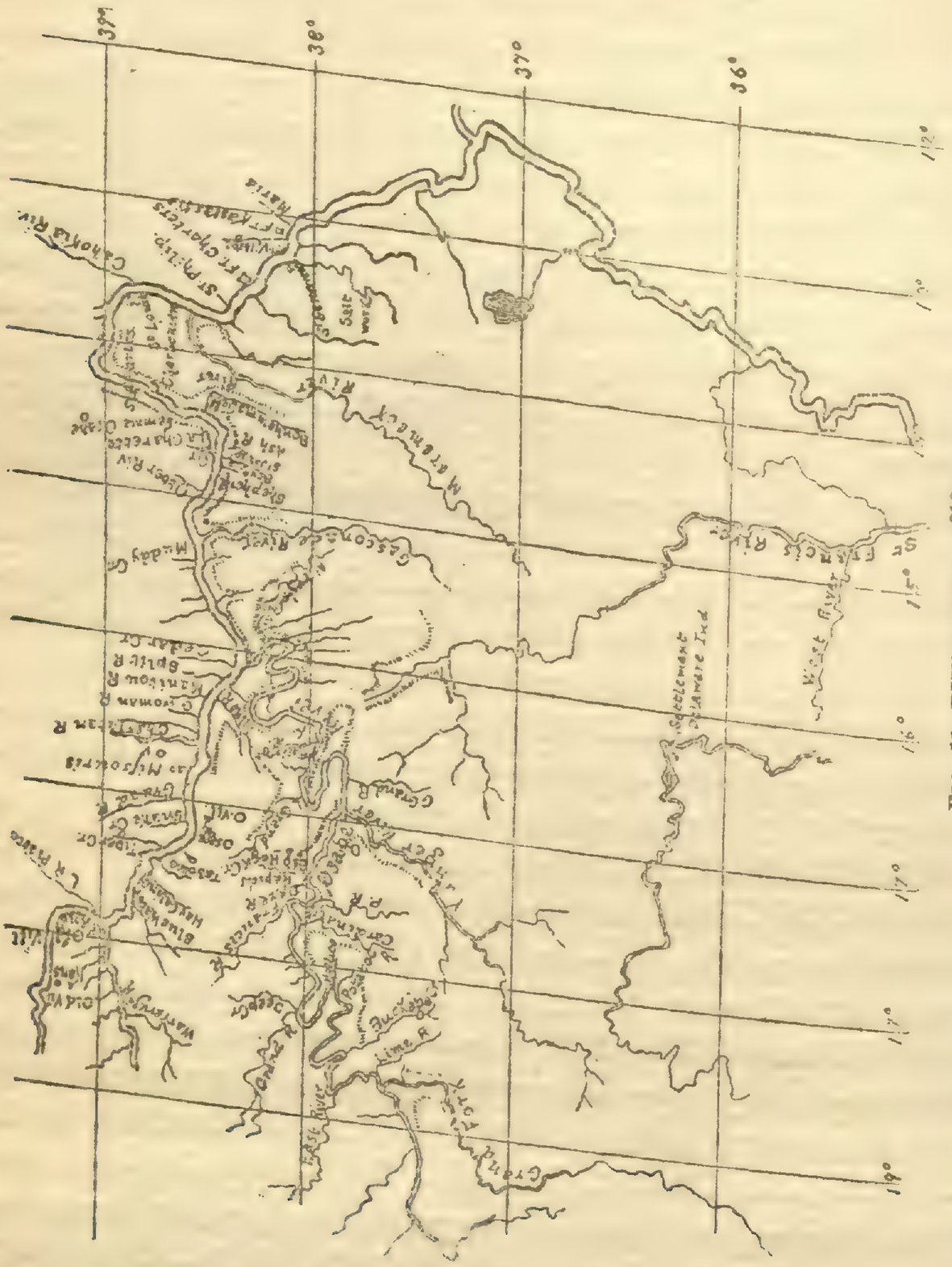

FIG. 11. PIKE MAP — 1810.
Initial Merid. at Washington.

The year 1815 brings us to what we may consider the beginning of the Land Office surveys in the State. During October of that year the Fifth Principal Meridian was begun at the mouth of the Arkansas river and was run north to the Missouri, reaching this stream December 27th, 1815.* Upon this line all of the subdivisions in the State are based. The survey was made with a compass. No record is contained in the copy of the field notes in the Land Office at Jefferson City, of any observations for the variation of the needle, but such must have been made, for the line to have been run with any approach to accuracy.† In the Land Office Instruction for Deputy Surveyors, dated 1856, it is stated that "Base and Meridian Lines in the District were formerly run with a common compass, and in many instances are far from being correct." Burt's solar compass was later adopted whenever practicable. The instructions further specify that, where local attraction exists, other means than the needle must be used. The law did not require the determination of the latitude and longitude of the base lines and principal meridians.

The Land Office surveys were pursued on what is termed the rectangular system, and were continued in the State up to about the year 1850. The surveys in Bates county and those in the northwestern countries of the Platte purchase were among the latest. In the former, work was done during the years 1843 to '44, and, in Atchison county, during the years 1846 and '47. The last contract recorded in the Missouri contracts is for April, 1852, when some small fractions of sections were surveyed along the Iowa line.

This system of surveys, though very imperfect in plan and inaccurately executed, furnished a vast amount of data for the development of cartography in the State, especially such as related to the details of the locations of the rivers and smaller streams. The results of these surveys, it will be seen later, are incorporated in many subsequent maps.

* The survey was made by P. K. Robbins, under instruction from Wm. Rector, Surveyor of the Territory.

† Mr. J. S. Higgins, of St. Louis, informs the writer that such observations are recorded in the copy of the original field notes preserved in the Land Office at Little Rock.

In the year 1816 what was then known as the Indian boundary line and what became later a portion of the State boundary line was run north from the mouth of the Kansas river to the present Iowa line, and thence east to the Des Moines river. The survey was made by J. C. Sullivan, deputy surveyor, under instructions of William Rector, surveyor of the territories of Illinois and Missouri. According to the original letter of instructions, attached to the field note book, the deputy surveyor was to run a line north "agreeably to the true Meridian, which you will ascertain before you commence your survey. And if the weather should permit you will frequently make observation of the variation of the needle and will regulate your compass according to the results of your several observations." The line was run, in accordance with these instructions, 100 miles north from the mouth of the Kansas river and thence east a distance of 150 miles and 40 chains to the Des Moines river.

In the year 1820 the State of Missouri was admitted to the Union. The boundaries are described in the act of admission as follows: —

"Beginning in the middle of the Mississippi river, on the parallel of thirty-six degrees north latitude; thence west, along that parallel of latitude, to the St. Francois river; thence up and following the course of that river, in the middle of the main channel thereof, to the parallel of latitude thirty-six degrees and thirty minutes; thence west along the same to a point where the said parallel is intersected by a meridian line passing through the middle of the mouth of the Kansas river, where the same empties into the Missouri river; thence from the point aforesaid, north, along the said meridian line, to the intersection of the parallel of latitude which passes through the rapids of the river Des Moines, making the said line to correspond with the Indian boundary line; thence east from the point of intersection last aforesaid, along the said parallel of latitude, to the middle of the channel of the main fork of the said river Des Moines; thence down and along the middle of the main channel of the said river Des Moines, to the mouth of the same, where it empties into the Mississippi river; thence due east to the middle of the main channel of the Mis-

sissippi river; thence down and following the course of the Mississippi river, in the middle of the main channel thereof, to the place of beginning."

The boundary line from the mouth of the Kansas river to the northwestern corner, and thence east to the Des Moines river, is the same as the old Indian boundary line above described as surveyed in 1816. This was apparently accepted as a correctly located State line up to the time of the Platte purchase, in 1836. Immediately after this, however, during the summer of 1837, a new survey of this line was made, in accordance with an act of the General Assembly of Missouri. This line was surveyed by Joseph C. Brown. It began at the rapids on the Des Moines river on the old Indian line. The longitude of this point was calculated from Elliott's determinations, at the mouth of the Ohio, and from the measurements of the Land Office survey, and was determined to be 91° 46′ 40″ west of Greenwich. The latitude was determined by astronomical observatious to be 40° 44′ 6″ north. Several latitude determinations were made along the line and observations for the variation of the compass were frequently taken; a compass was used in the work, and its bearings were checked by back sights. The total length of the line from the Des Moines to the Missouri river as measured, was 203 miles and 33 chains. The longitude of the N. W. corner was calculated to be 95° 39′ 13″ and the latitude, from observations about 40° 44′.

The location of this survey seems, however, not to have been acceptable to the State of Iowa and more or less litigation arose therefrom. Hence in 1850, a new survey was ordered by the Supreme Court of the United States.* The starting point taken was Sullivan's N. W. corner, established by the Survey of 1816.† The latitude of this point was determined to be 40° 34′ 40″ 3 N.; the longitude calculated from the Land Office maps was determined to be 94° 30′ W. of Greenwich. The line was run due west on a parallel for a distance of 61 miles and 61 chains to the Missouri river;

* See Howard's Report, Vol. 10.

† The surveyor for Missouri was R. Walker, and the one for Iowa was Wm. Dewey.

Burt's solar compass was used. The line east followed Sullivan's old line, notwithstanding the fact that the latter was found to be quite crooked and to diverge from the parallel in many places. It was marked by posts every 10 miles. The length of this portion of the line was found to be 150 miles and 51.80 chains, making the total length of the boundary line, from the N. E. to the N. W. corner, 211 miles, 32. 80 chains, a result differing about 8 miles from that of the Brown survey of 1837. The line as thus surveyed was adopted.

The survey of the western and southern boundaries of the State from the mouth of the Kansas river to the St. Francois river, was originally begun in September of the year 1823, shortly after Missouri became a State. The surveyor was Joseph C. Brown, acting under the instructions of Genl. Wm. Rector, surveyor of the U. S. lands of Illinois and Missouri. The line was completed December 8, of the same year. According to the original field notes, it started from the mouth of the Kansas river, after observations for the magnetic variation had been made. Thence, it continued south for a distance of 177 miles to a determined latitude of 36° 30′ north.* At this point the S. W. corner of the State was marked by a stone post, and the line was continued east to the St. Francois river, under great hardships and difficulties. Determinations of latitude were made at intervals along the W. to E. line and the party was at one place as much as 31″ out of position. The line was run with a compass, and a theodolite, sextant and an artificial horizon were part of the equipment. The line between the St. Francois and Mississippi rivers was not run at the time owing to the exhaustion of the party, the equipment and the funds. The distance from the S. W. corner to the St. Francois river was determined to be 232 miles and 28 chains. No latitude determination was made at the St. Francois river.

The survey was continued by Brown the following year, in October, 1824. According to the field notes the latitude of

* Later calculations with the aid of the Nautical almanac led Mr. Brown to place this point at 36° 30′ 4″.

A resurvey of the portion of this line between the 26 mile post and the Marais des Cygnes river on the 62 mile, was made in November, 1844.

the point reached at the end of the past years work was 36° 30′ 11″. Thence the course of the St. Francois river was meandered out down to a determined latitude of 36° N. Thence a line was run due east to the Mississippi river.

The Brown survey, probably on account of the acknowledged inaccuracies and for other reasons, was not acceptable and, hence, we find, in the year 1843, a new survey of the southern boundary of the State begun under the direction of a joint commission from Missouri and Arkansas, in accordance with acts of the respective legislatures. The survey was begun on the Mississippi river on the latitude 36° N. which was determined with a sextant and an artificial horizon. The line was run thence west to the St. Francois river, a distance of 36 miles and 50 chains. It was found throughout its whole length, to be about 600 yards N. of the line determined by the Brown survey. Thence, they proceeded north to a point on the St. Francois river which they determined to be at 36° 30′ N. and about one chain north of the old Brown line. The line thence ran W. soon crossed the Brown line and kept south of it the remainder of the distance. At no other point, however, was it so much as a half a mile south. It terminated 4.83 chains due south of the southwestern corner of the State, as marked by Brown in 1823. This last survey made the south line of the State about ten miles longer than did the earlier one and this latter result accorded with the Land Office surveys. This appears to be a carefully conducted survey and a neatly drawn map of the line accompanies the copy of the original notes in the Land Office at Jefferson City. The line as marked by this survey was accepted as the south boundary of the State and is still recognized as such.

Returning from this digressive sketch of the history of the State boundary surveys we will take up again the chronologic notice of explorations and maps of our area.

Rector's and Roberdeau's map, was compiled in the year 1818. It is entitled "Sketch of the Western part of the Continent of North America, between latitudes 35° and 52° N." It extends from the 87th Meridian to the Pacific ocean, and is on a scale of about 47 miles to the inch. It was originally drawn by Roberdeau of the U. S. Topographic

Engineers under the direction of Wm. Rector, Surveyor of the U. S. for the territories of Missouri and Illinois, and was presented by the latter to the General Land Office. It was presented as probably the most correct map of the country extant at that time.* In it are presumably incorporated the results of the meridian and boundary surveys which had been made in Missouri prior to that date. The Mississippi river is, however, placed from 60 to 100 miles east of its true position, and the mouth of the Kansas river is fully 30 miles too far east. St. Louis and the Missouri river are some 80 miles south of where they should he. These results indicate that the observations of the preceding Lewis and Clarke and Pike expeditions were not made use of.

The Long Expedition was conducted during the years 1819 and 1820. The results are published under the title of "Account of an Expedition from Pittsburg to the Rocky Mountains," etc., "compiled by Edwin James, botanist and geologist for the expedition, In two volumes with an atlas." Philada: H. C. Carey and I. Lea, 1823. The party proceeded down the Ohio river to its mouth, and thence up the Mississippi and Missouri rivers. They were provided with chronometers, sextants, compasses and a telescope. Their results are embodied in a map accompanying the report, on a scale of about 75 miles to the inch. A portion is shown on the sketch on page 85, which is from a tracing of the map. Eliot's determinations of 1797–98, at the mouth of the Ohio are quoted and are referred to in later determinations. These are:

Lat. 37° 0′ 22.9″ N.
Long. 88° 50′ 42″ W. of Greenwich.

Proceeding up the Mississippi river the position of Cape Girardeau was determined.

From three observations— 37° 18′ 39″ N. Lat.
From traverse measurements from the mouth of the Ohio 89° 17′ W. Long.

The mouth of the "Merameg" river was determined to be at 39° 23′ 29″ N. Lat.

* A reduced copy of this map is published opposite p. 23 of Vol. XI, of he reports of the Pacific R. R. Surveys.

The location of St. Louis was variously established as follows:—

Lat. (mean of three observations),	38° 36′ 18″ N.
Long. " " " "	90° 6′ 15″ W.
" (from traverse measurements from mouth of Ohio),	90° 2′ 35″ W.

FIG. 12. LONG MAP — 1820.
Initial Merid. at Greenwich.

The mouth of the Missouri river was similarly determined to be at:

Lat. (mean of four determinations),	38° 51′ 39″ W.
Long. (from lunar observations),	89° 57′ W.
Long. (from traverse measurements),	90° 00′ 40″ W.

These first two results accord quite closely with Capt. Lewis's earlier observations.

The following determinations were further made, up the Missouri river: —

Franklin, Howard Co.

Lat. (mean of three determinations), 38° 57′ 09″ N.
Long. (mean of three determinations), 92° 57′ 05″ W.

Fort Osage.

Lat. (mean of three determinations), 39° 09′ 33½″ N.

The State line is introduced in the original map in the position shown on the accompanying sketch; also the old Osage boundary line. The true drainage of the Ozark region is faintly suggested, though the peculiar system of tributaries of Black river is wholly imaginary.

Finley's map of North America was published in 1826, under the title of "Map of North America, including all the recent geographical discoveries." A reduced copy is included opposite p. 30 of Vol. XI., of the Pacific railway reports. The portion embracing Missouri shows nothing in advance of the earlier Long map, and is probably largely copied from that map. The Ozark mountains are outlined in a general way, but the drainage system of that area is very inaccurate.

In 1825 a survey of a road from Fort Osage to Taos in New Mexico was begun by order of the U. S. Government, by J. C. Brown. Fort Osage was the startling point, which was taken at 93° 51′ 03″.*

In 1837 there appeared a map on a scale of 50 miles to the inch, compiled by the United States Topographical Bureau, entitled "A map illustrating the plan of the defenses of the western and northwestern frontier." It was compiled under the direction of Col. J. J. Abert, and is published in Senate Document No. 65 second session, 25th Congress. The representation of Missouri is much in advance of that of any previously published. The Mississippi river is placed about 10 miles west of its true position, but the latitudes of points along it, in, and adjacent to the State, are fairly correct. The drainage displayed of the interior bears, in a general way, a close resemblance to that of our modern maps; especially of the Ozark region is the representation of the drainage an ad-

* See Pacific R. R. Reports, Vol. XI, p. 25.

vance over earlier maps. From the results of the Land Office surveys many such details were doubtless incorporated.

Between the years 1836 and 1840, certain surveys were conducted and observations were made by I. N. Nicollet, for the government along the Mississippi and Missouri rivers. The results are contained in Senate Document No. 237, 26th Congress, second Session; a map accompanies this embracing the territory between 38° and 40° 30′ of Lat. and between 89° and 101° of Long. He is credited with having made the first use of the barometer in connection with such work in the west. The longitude of St. Louis cathedral was determined to be 90° 15′ 10″, and that of Fort Leavenworth 94° 44′.*

A fair summary of the existing knowledge of geographic locations about the middle of this century, is contained in a table in "French's Historical Collections of Louisiana" (1846–53) in which, along with many others beyond the limits of Missouri, the following locations are given. They are derived from determinations of Long, Nicollet and others.†

	Distance from Gulf. Miles.	*Altitude of surface of water above Gulf. Feet.*	*North latitude.*	*Longitude West of Greenwich.*
New Madrid	1115	.....	36° 34′ 30″	89° 17′ 15″
Cape Girardeau	1257	.....	37° 18′ 39″	89° 17′ 0″
St. Genevieve, church	1330	372	37° 59′ 47″	90° 11′ 10″
St. Louis, cathedral garden	1390	382	38° 37′ 28″	90° 15′ 39″
Missouri, mouth of, south bank.	1408	388	38° 50′ 50″	90° 13′ 45″
Gasconade river, mouth of	1513	.....	38° 41′ 40″	.....
Portland, Callaway county	1523	.....	38° 42′ 57″	91° 40′ 15″
Osage river, mouth of	1543	.....	38° 35′ 0″	.....
Boonville	1604	530	38° 57′ 18″	92° 41′ 30″
Grand river, S. W. of mouth	1670	.....	39° 19′ 0″	.....
Old Fort Osage, right bank	1748	.....	39° 9′ 33″	.....
Kansas river, mouth of	1790	.....	39° 5′ 25″	.....
Fort Leavenworth	1820	746	39° 22′ 40″	94° 44′ 0″

* According to the measurements of the Land Office surveys the longitude of Fort Leavenworth is 94° 58′, while the most recent results make the longitude of the observatory of Washington University, St. Louis, 90° 12′ 30″. Similarily the longitude of Fort Osage as determined by J. C. Brown in 1826 was 93° 51′, while the Land Office measurements make it 94° 15′; the longitude of Westport was determined by Freemont in 1843 to be 94° 22′, and by Land Office measurements it is 94° 37′.

† Historical Collections of Louisiana. By B. F. French. Vol. II, p. 298. New York: Wiley & Putnam, 1846–53.

In the year 1858 was published the map compiled by Lieut. G. K. Warren to accompany the reports of the Pacific railway surveys. It is contained in Vol. XI of the series of reports. In preparing this map Lieut. Warren studied carefully many of the previously published maps which have been described here, and he utilized the various astronomical determinations of the earlier exploration, though in a discriminating way; he also had available the Land Office records and to these were added the data obtained by the newly executed surveys of the various practicable railway routes to the Pacific ocean. The result was, consequently, a map much in advance of anything so far published, both as to accuracy of location and amount of detail included. A copy of a tracing of this map is presented here, and a brief inspection will suffice to show that, for the scale used, a much better outline map of the State could hardly be prepared from our best maps of to-day.

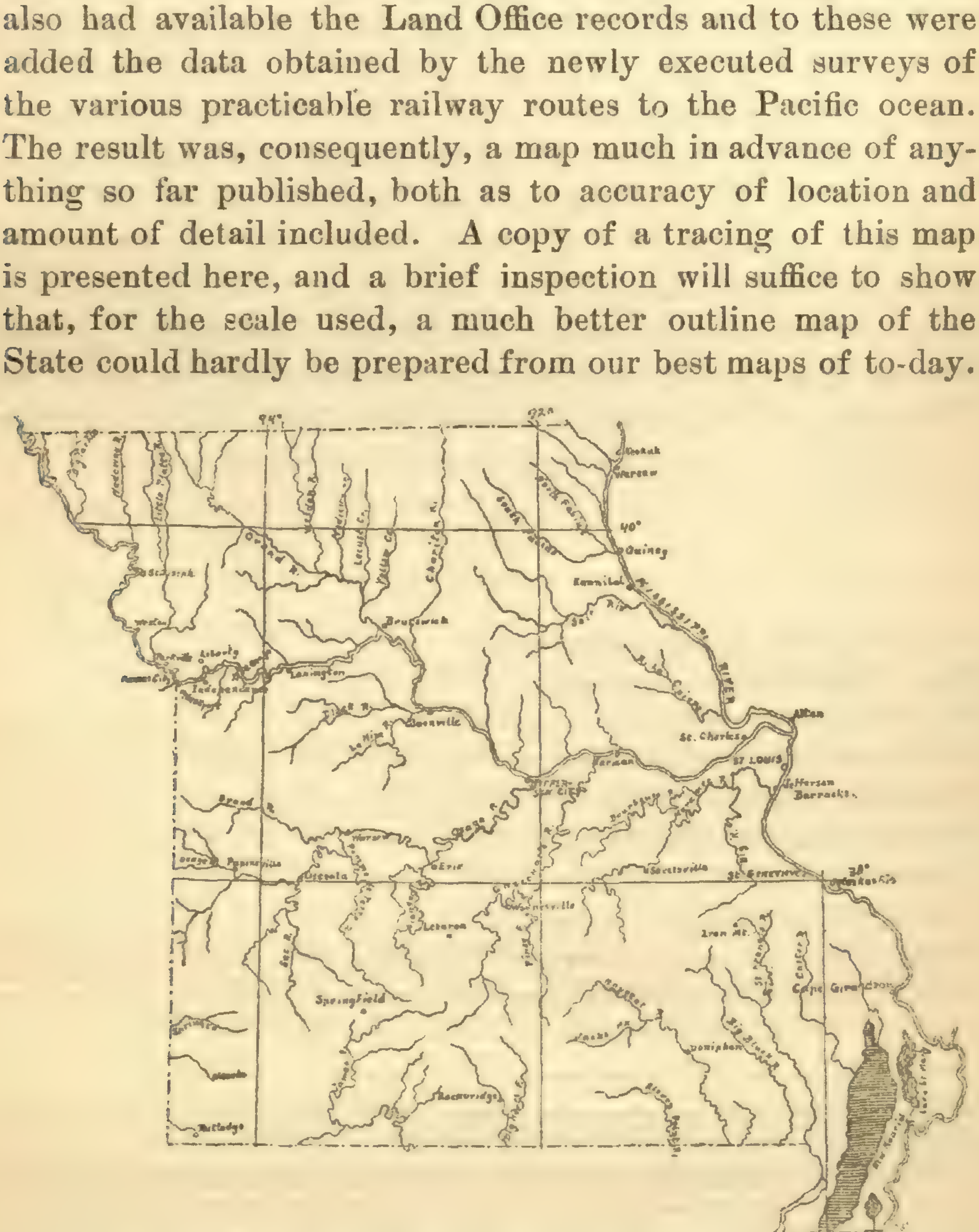

FIG. 13. WARREN MAP — 1857.
Initial Merid. at Greenwich.

With the Warren map and the results of the Pacific railway

surveys, we reach the end of what we may term the period of explorations, when the work was of the nature of a reconnoissance, when determinations were confessedly of only very approximate nature and little or no detail was attempted. During the next decade the war and the succeeding years of reorganization prevented any further progress of geographic work. Not until after the year 1870 was such resumed and we then pass into what may be called the period of exact and detailed mapping.

The work of the U. S. Coast & Geodetic Survey.— The beginning of precise and detailed geographic work was the extension of the trans-continental chain of triangles by the U. S. Coast and Geodetic Survey from Illinois into Missouri. This was started in the year 1871, when a base line was measured in the Missouri bottoms and several stations were selected. During the year 1873 triangulating was resumed and was extended 32 miles west of St. Louis; during the years 1874 and 1875 it was extended to the Gasconade river and during the years 1879 to 1886 the work was continued uninterruptedly and the triangles were carried entirely across the State into Kansas. The position of this chain of triangles in the State is clearly shown in the diagram on page 90. Following this belt of triangles, precise-leveling has now also been completed across the State by the Coast and Geodetic Survey. This work was carried from St. Louis to New Haven in the year 1882; from New Haven to Jefferson City in 1888 and from Jefferson City to Kansas City in 1891.

The Mississippi River Commission was organized in the year 1879. At this date only about 18 miles of the river from Cairo down, had been mapped. Since that time, according to data kindly furnished by Capt. Carl F. Palfrey, the present secretary of the Commission, their operations have been as follows, up to 1891:—

"Under the appropriations of 1881–82, in the working seasons of 1881–2–3, this work was carried southwards beyond the limits of Missouri. Also triangulation was carried northwards to Keokuk, Iowa, covering the Missouri front. Under the appropriation of August 11th, 1888, in what remained of

FIG. 14. Diagram illustrating progress of mapping in Missouri, up to the end of the year 1891.

the season of 1888 and in that of 1889, topographical work was completed from Cairo to Alton, Ill. The section of precise levels from Illinois river to Cairo was run in 1880; that northward from Illinois river in 1883. Even if there should be no appropriation at this session of Congress, the topography will reach the northern boundary of Missouri during the working season of this year. The reduction and publication of maps has followed the same course as the field work. Ten sheets, scale 1:20000, from Cairo to the southern boundary of Missouri were published in 1888–89; 14 sheets, from Cairo to Carondelet, have been published in 1890–91. Unless there is an appropriation at this session it is not probable that publication can be continued at present.''

The area mapped by the Commission is shown on the diagram opposite page.

The published maps of the Mississippi river Commission are on two scales. One series consists of large sheets 22 inches by 36 inches, on a scale of about 31 inches to the mile. These show all detail of importance to the navigator, such as the shore line, the positions of bars, and the depths of the water; the topography on each side of the alluvial plain is shown in five foot contours, timbered and open country are distinguished and many other recognizable land marks are introduced. The second series of maps are not much more than reductions of the larger maps and include less detail. They are issued on a scale of one mile to the inch, in sheets 12 by 22 inches.

The work of the Missouri River Commission was begun in 1878. Their mapping is similar to that of the Mississippi river Commission and in the words of their reports, embraces "an accurate delineation of the shore line, islands and sand bars,'' the general topographical features of the valley and the line of bluff bordering the same, the whole checked by a system of triangulation carried along the river banks.'' Soundings were also made along lines normal to the current and from 500 to 1500 feet apart. The survey commenced in 1878 at the town of Weston and was extended thence to Boonville during that year; a line of unchecked levels was carried along with it. During 1879 the survey and line of unchecked

levels was continued to St. Louis. In 1880 a line of carefully checked levels was run from Sioux city, Iowa, to the mouth. During the succeeding years, up to October 1884, no further surveying was done, but, during the fall of that year, the Commission determined upon a secondary triangulation of the river from bluff to bluff and also determined to establish lines of permanent bench marks, the whole to be connected with the former survey. This work was commenced October 12th at Glasgow and reached Boonville December 15th; the work was continued all of the winter and was closed with the Coast Survey triangulation station at Tavern Rock the following May. In 1889 triangulation was extended above Fort Leavenworth. In the autumn of 1890 a new shore line survey was made of the whole of that portion of the river, within the State. One series of maps is published containing the results of this work, on a scale of one mile to the inch. The area covered by these sheets is also indicated on the diagram on page 90. They contain less detail than do the larger sheets of the Mississippi river survey.

The United States Geological Survey has undertaken, as part of its work, the preparation of a topographical atlas of the country. For this purpose, along with work prosecuted elsewhere, maps have been constructed of about one-third of the area of this State. The distribution of this mapping is clearly shown in the diagram on page 90. The survey was begun in the year 1884 and was continued uninterruptedly up to July of 1889. Since that time no further work has been done. The product up to the present date is 25 sheets in Missouri and five sheets including portions of Missouri and Kansas, all on a scale of $\frac{1}{125000}$, or about 2 miles to the inch, with a contour interval of 50 ft.; also two sheets, including St. Louis and parts of St. Louis county, and Illinois, on a scale of $\frac{1}{62500}$, or about one mile to the inch, with a contour interval of 20 ft. All of these sheets are of uniform size, $16\frac{1}{2}$ by 20 inches, and the area represented on each is a geographic one and is a fraction of a square degree of latitude and longitude. These maps have represented upon them the drainage in blue; the hypsometry in brown; the cultural features, such as towns, railroads, roads, political and

cadastral division lines in black. They constitute the first series of maps which even attempts to display, in a comprehensive and systematic way, the topography of the State, or of any large part of it. They are much in advance of anything previously published. The principal objections which can be urged against them are that the scale is too small and the contour interval too great for the characteristics of much of the topography of the State to be well brought out or for many valuable details to be closely located or even included. Further the method of work employed furnished a weak vertical control and the altitudes represented are, hence, very inaccurate in places. A fifty foot contour and a scale of two miles to the inch though calculated to well display the general features of a mountainous country of large and bold features, fails to be adequate in a prairie country where differences of elevation of twenty feet are significant and conspicuous.

The method of construction of these maps is described in the following words by Mr. Henry Gannett, Chief Topographer of the United States Geological Survey, in a letter to the writer: —

"The primary horizontal control consists of the triangulation of the Coast and Geodetic Survey and of the Missouri River Commission, supplemented where these surveys have not extended, by astronomic determination.* The secondary horizontal control consists in part of the location made by the U. S. Land Surveys (their township and section corners) this system having been connected with the primary locations for the purpose of eliminating their accumulated errors; and in part of traverses of roads and other routes of travel. In these traverses the directions were measured by compass and distances by the wheel. The primary measurements of height were obtained from levels along the Missouri river and the profiles of railroads, secondary height measurements were made by the cistern and aneroid barometers, the latter being corrected by comparison with cistern barometer and by comparison with the known heights of points upon railroads.

* Points were established at Springfield and Bolivar, Mo., and at points adjacent to the State line in Kansas. A. W.

The sketching was done in approximate contours upon sketching boards directly from the country as copy.*

"I have not at hand the figures of cost attendant upon this work heretofore, but from experience in similar regions in recent years, I should place the expense of the work in the northern prairie portion of the State, including all expenses connected with it, at about two dollars a square mile. In the broken and heavily timbered southern portion of the State I would say that a satisfactory map could be made for between three and four dollars per square mile, and here the cost would depend greatly upon the character of the men engaged upon it, for it is a very difficult piece of country to survey.† The above figures imply of course that the map is to be made for publication upon the scale of $\frac{1}{125000}$. Increase of scale would increase the expense incident to the survey considerably." ‡

A serious defect in these maps for many every-day uses is the omission of the township range and section lines. The political division lines are shown, but these are much less permanent and of less general use than are the omitted cadastral lines.

The Missouri Geological Survey has had an intermittent existence since the year 1853. The first survey, under Prof. G. C. Swallow, was in operation from that year until June, 1861; the second survey, under Messrs. A. D. Hager, Raphael Pumpelly and G. C. Broadhead successively, continued from the year 1870 until 1875; the third survey, under Mr. Arthur Winslow, began in the autumn of the year 1889 and is still in

* Since this work was commenced, in 1884, the improvements of instruments and methods have been such that in similar country there will be considerable differences in the methods employed at present, for instance the cistern barometers would not be employed but in place thereof lines of dip angles would be run at intervals for the purpose of checking the indications of the aneroids which would be employed in the measurement of minor heights. The plane table provided with a compass for orienting would be employed in traversing.

† These estimates do not include the cost of engraving and printing. A. W.

‡ Similar maps on a scale of 1:62,500 constructed by the U. S. Geological Survey of Massachusetts, Rhode Island and Connecticut, cost in the vicinity of $10.00 per square mile. A. W.

progress. The work of the First and Second Geological Surveys included little original work in the line of geographic mapping. Accompanying the county reports of these surveys, there are small maps published on scales of three and four miles to the inch of some thirty counties. These maps contain, in addition to the geological matter, such facts of geography and topography as could be obtained from the Land Office plats and from published maps, supplemented by observations made in the field while prosecuting geologic work. The counties are printed on separate sheets on which the township range and section lines are shown, and the towns, railways and drainage; at times prominent elevations are indicated by hachure lines, but this only at intervals. The amount of detail shown on the different sheets is quite variable. In addition to these county maps, there were published under the Pumpelly management, as a result of original work, a topographic map of Pilot Knob and vicinity on a scale of about 1200 feet to the inch, and, under the Broadhead management, a contoured map of the Granby mining district on a scale of 300 feet to the inch.

The Third Geological Survey, now in progress, has undertaken, as part of its work, the preparation of detailed maps of different portions of the State. These maps include the details of the topography as well as those of the geology proper. The scale adopted is $\frac{1}{62500}$ or about one mile to the inch. The area represented by each sheet is a quadrilateral of 15″ extent in latitude and longitude; this may be, within the State, anywhere between 228 and 240 square miles. The size of the sheet, including the margin, is $16\frac{3}{4}$ by $20\frac{3}{4}$ inches. This work has been prosecuted during the field seasons of the years 1890 and 1891, and, as a result, there have been surveyed and plotted up to date ten sheets, distributed as shown on the diagram opposite p. 91. During the present field season three or four more will be surveyed.

The map attached at the end of this paper is a printed copy of one of these sheets, from engravings on stone. As is there shown the drainage, the hypsometry and the cultural features are represented respectively in blue, brown and black, as on the sheets of the U. S. Geological Survey. The scale is, how-

ever, twice as great, the contour interval is 20 ft. instead of 50 ft., the township and section lines are added and the distribution of the formations and other geological facts are shown.* The adoption of the larger scale permits the representation of much valuable detail which is omitted from the U. S. Geological Survey sheets and the methods used insure much greater accuracy in the determination of both horizontal position and altitude.

The methods by which these maps are constructed are somewhat different from those used by the U. S. Geological Survey. They are the outgrowth of work prosecuted under the writer's direction during the past four years; they are the most satisfactory, to his knowledge, for accomplishing all the ends in view, both with regard to cost as well as quality of product. The geographic co-ordinates of the sheet have first to be determined. For this purpose the results of the triangulation of the U. S. Coast and Geodetic Survey, and of the Mississippi and Missouri River Commissions are used where applicable; elsewhere astronomical determinations have been made. These results furnished the primary horizontal control, and subject to such control, the township and range lines are located on the sheet. Within each cadastral township, so outlined, the section lines were located from the Land Office sheets, discrepancies within such townships being distributed. The railway lines were plotted from the maps of the respective roads and these, together with the section and other land division lines, served as lines of horizontal control. The drainage has been plotted, in part, from the Land Office sheets, at least the points of intersection of streams and section lines have been generally obtained in this way. Such locations are, however, checked by frequent intersections with the meander lines of the topographic work. Vertical control for contouring is obtained primarily from the precise leveling of the Coast and Geodetic Survey and of the River Commissions and, secondarily, from the profiles of the various railways. In addition to these, lines of level are run by the Geological Survey through each township, which furnish frequent bench marks and, in addition, fix with exactness the relative eleva-

* A section sheet accompanies this map, as issued by the Geological Survey, showing the structure of the area and details of the stratigraphy.

tions of coal beds and topographic features of special importance. Between these lines, altitudes have been determined by aneriod barometer measurements along the lines of meander surveys. Such meander work was performed with hand compass and paced distances following along roads, or along section or other land lines, and, in all cases, was checked by frequent intersections with such lines. In such surveys the topography was sketched, at the same time, directly into the note book and all observed geological occurrences were located in their proper topographic positions. These methods are accepted as adequate for the construction of a topographic map for purposes in view, on the scale and with contour interval used. More must not, however, be *demanded* of such maps, than these considerations warrant, though they will prove of value in the future for many other industrial and scientific uses than those for which they were especially constructed. They portray with exactness the distribution of upland and lowland with reasonable faithfulness the relative elevations of the various hills. It is not maintained that the exact amount of grading necessary for the construction of a railway across the areas represented can be calculated from the study of these maps; yet, on the other hand the general question of the practicability of construction along any line can be determined at a glance.

The plan of publication proposed for these sheets contemplates that they shall be issued under paper covers, together with the accompanying section sheet, unfolded at the end of a folio report of a dozen or more pages of the same size as the map. A series of these sheet reports can be bound later under more substantial board covers. The areas selected for such detailed work, are those which are of prominent economic importance, or which are of great geologic and scientific interest. It is the intention to complete several such sheets each year, along with the other work of the survey of more general nature. The value of such detailed work to the State is second to none among the various products of the Survey's operations and we feel little hesitation in predicting that this series of maps and accompanying sections and reports will prove of more substantial and enduring value than any other of the publications.

The cost and the quality of this mapping depend very greatly upon the character and talent of the men executing it. The work demands a sound constitution, industry and perseverance, attention to details and, above all, an eye for topography. The sluggard has no liking for the work, the slurrer should have no place in it. This work of the Survey so far, is distributed over prairie and timber country, in flat and in hilly portions of the State. The results have been reached at the extremely low cost of not more than $2.00 per square mile. This includes the cost not merely of the topographic work, but also of incidental geological work, as well as the reduction of notes and the plotting of maps and sections. The cost of engraving and printing is, of course, not included, nor is the cost of triangulation, of astronomical work, or of administration. The figure given covers merely the salaries and expenses of the parties doing the work in field and office. It is believed that the work can be extended into any portion of the State at an average cost of little more than this amount and an allowance of $3.00 per square mile is certainly most ample.

As a necessary preliminary to the detailed mapping in the State the latitudes and longitudes of a number of points have been determined. These were made in part by the U. S. Geological Survey and in part by the U. S. Coast and Geodetic Survey, both being assisted by Prof. H. S. Pritchett of the Washington University Observatory. The points thus far determined as indicated on the map are: —

	Lat.	*Long.*
SPRINGFIELD, GREEN COUNTY (U. S. G. S.)		
Pier, in Drury College grounds	37° 13′ 15.96″	93° 17′ 17.58″
BOLIVAR, POLK COUNTY (U. S. G. S.)		
Pier, in S. W. Baptist College grounds	37° 36′ 35.22″	93° 24′ 47.68″
ST. LOUIS (Pritchett)		
Pier, Observatory Washington University	38° 38′ 3.6″	90° 12′ 30″
IRONTON, IRON COUNTY (U. S. C. & G. S. & Mo. G. S.)		
Pier, just east of depot	37° 36′ 30.76″	90° 37′ 36.68″
POTOSI, WASHINGTON COUNTY (U. S. C. & G. S. & Mo. G. S.)		
Pier, Court House yard	37° 56′ 14.62″	90° 47′ 16.16″
MACON CITY, MACON COUNTY (U. S. C. & G. S. & Mo. G. S.)		
Pier, Court House yard	39° 44′ 32.9″	92° 28′ 14.2″
COLUMBIA, BOONE COUNTY (Pritchett)		
Observatory State University	38° 56′ 51.6″	92° 19′ 34.05″
GLASGOW, HOWARD COUNTY (Pritchett)		
Observatory College	39° 13′ 45.6″	92° 49′ 29.55″

Reference to surveys and original maps in the State, would not be complete were mention omitted of all the various railway surveys and the resultant maps. These have furnished a great amount of data and, were all the results of such surveys available we should have material for the construction of topographic maps of considerable portions of the State. As it is their locations of constructed lines are valuable base lines for all operations of geographic surveying and their profiles are invaluable for determinations of altitude.

Innumerable maps have been constructed of the State of which no mention has been made here. The reason for this is that these maps are compiled and are not prepared from new and original surveys. All of what is entitled to the name of original geographic work, in an extended sense, is referred to here. Many excellent and serviceable maps have been compiled from the Land Office plats, supplemented by railway maps. Many county atlases have been similarly prepared. To these, county roads, post-offices, school-houses, churches, boundaries and other such features are added from county records and from observations on the ground.

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FLOWERS AND INSECTS — LABIATÆ.

CHARLES ROBERTSON.

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FLOWERS AND INSECTS — LABIATÆ.

CHARLES ROBERTSON.

Teucrium Canadense L.—The plant is rather common in low grounds. The stems rise from 5 to 10 dm. and bear rather conspicuous racemes of flowers which are pale purplish marked with darker purple.

The fertilization of the perfect flower is well described by Foerste, in Am. Nat. XX, 66. It is proterandrous, as in other species of the genus. Foerste thinks that spontaneous self-fertilization occurs, and states that the visits of the bees seem to be less frequent than with most cross-fertilized Labiatæ.

The flowers project nearly horizontally. The tube is cleft on the upper side, so that even the lateral divisions of the upper lip form part of the lower lip. The stamens and style, therefore, are not protected as in the typical Labiates, but rise nearly upright and bend forwards. If the flowers were arranged in a nearly flat-topped inflorescence, as in *Pycnanthemum*, we would, no doubt, find them visited for honey and pollen by quite a miscellaneous set of insects. The form of the inflorescence, however, serves to offset some of the disadvantages in the structure of the flowers, for the stamens are protected by the flowers above them; so that it is not easy for insects to land directly upon them, and the lateral position of the flowers makes it inconvenient for the less specialized flower-insects to land upon them. This plant is gynodiœcious, the female form being much more common in my neighborhood.

I have found the flowers in bloom from June 24 to Aug. 13. On five days, July 6–10, I observed the following visitors, all sucking honey :—

Apidæ: (1) Apis mellifica L. ☿, ab.; (2) Bombus virginicus Oliv. ☿; (3) Melissodes bimaculata Lep. ♂♀; (4) Magachile brevis Say ♀.

As far as observed the flowers of *Teucrium* are adapted to bees, and most of the species specially to bumble-bees, as shown in the following table. In some of the species the tube is so shortened as to admit mid-length or even short-tongued bees.

	BOMBUS.	OTHER BEES.	OTHER INSECTS.	TUBE IN MM.
Teucrium Scorodonia—Low Germany—Müller*	6	5	1	9–10
Pyrenees—MacLeod....	3	.....	.....	.....
Chamædrys—Alps—Müller.....	3	1	1	7–10
Pyrenees—MacLeod..	2	.....	.....	.....
Pyrenaicum— " "	4	.....	.....	.....
Montanum—Alps—Müller.....	6	1	1	6
Scordium—Low Germany—Müller..	.....	2	.....	4
Botrys— " "	.....	2	.....	.....
Canadense—Illinois.....	1	3	.....	6

Mentha Canadensis L.—The plant is common in wet places. The stem rises from five to ten dm., is much branched and bears in the axils of the leaves numerous whorls, each with many white flowers, whose lobes are faintly marked with purplish.

The flower has a form much as in *Lycopus*, the cleft upper lip appearing as an almost equal lobe of a four-lobed corolla. The slight irregularity has little significance, except as a trace of a former condition, for insects land indefinitely upon the flower clusters, approach the separate flowers from every side and receive the pollen on different parts of their bodies.

The plant is gynodiœcious. The hermaphrodite flowers are proterandrous. They expand about 3 by 5 mm., measure 5 or 6 mm. in length, the tube being about 3 mm. The anthers are exserted from 3 to 4 mm., the receptive stigma 5 mm. The female flower expands 3 or 4 mm., measures 4 or 5 mm. in length, the tube being about 3 mm. long. The anthers are imperfect and are included. The stigma is exserted about 2 mm.

*In the tables given in this paper, the observations of Müller in Low Germany are taken from his Fertilization of Flowers and Weitere Beobachtungen über Befruchtung der Blumen durch Insekten; those in the Alps from his Alpenblumen, ihre Befruchtung durch Insekten; those of MacLeod in the Pyrenees from De Pyreneeënbloemen en hare Bevruchting door Insecten, Gent, 1891.

I have found the flowers in bloom from July 25 to Sept. 16. On seven days, Aug. 13–Sept. 16, I observed the following insects visiting the flowers for honey :—

Diptera — *Bombylidæ:* (1) Exoprosopa fascipennis Say; *Empidæ:* (2) Empis clausa Rob. (MS); *Syrphidæ:* (3) Tropidia quadrata Say; (4) Syritta pipiens L.; *Dexidæ:* (5) Rhynchodexia sp.; (6) Scotiptera parvicornis Twns. (MS); *Tachinidæ:* (7) Jurinia smaragdina Mcq., ab.; (8) J. apicifera Wlk.; *Muscidæ:* (9) Lucilia sylvarum Mg.; (10) L. cornicina F.

Hymenoptera — *Andrenidæ:* (11) Augochlora pura Say ♂; *Philanthidæ:* (12) Eucerceris zonatus Say; *Sphecidæ:* (13) Ammophila vulgaris Cr.; (14) A. gracilis Lep.; (15) Isodontia philadelphica Lep.; *Pompilidæ:* (16) Pompilus marginatus Say; *Scoliidæ:* (17) Myzine 6-cincta F.; (18) M. interrupta Say.

Lepidoptera — *Rhopalocera:* (19) Pieris rapæ L.; (20) Ancyloxypha numitor F.

Coleoptera — *Lampyridæ:* (21) Chauliognathus pennsylvanicus DeG.

At first I expected to find a preponderance of hymenoptera, but I found diptera more abundant. The most frequent visitor was *Jurinia smaragdina*. In showing a preponderance of species of diptera, my list agrees with the lists of European species observed by Müller and MacLeod, as shown in the following table:—

	DIPTERA.	HYMENOPTERA.	LEPIDOPTERA.	COLEOPTERA.		
Mentha arvensis — Low Germany — Müller	11	4	1	....	....	16
aquatica — " "	18	5	....	....	....	23
sylvestris — Alps — Müller	8	5	3	....	....	16
Pyrenees — MacLeod	8	4	5	2	....	19
Canadensis — Illinois.....	10	8	2	1	....	21

Lycopus sinuatus Ell. — This species is common in wet places. The stems sometimes grow as tall as one metre, and are considerably branched. The flowers are arranged in axillary whorls.

The plant is gynodiœcious.* The corolla is white and

* According to Schulz, L. europæus bears female flowers — Beiträge zur Kentniss der Bestäubungseinrichtungen u. d. Geschlechtsvertheilung b. d. Pflanzen.

expands about 3 mm. It measures about 3 or 4 mm. in length, the tube 2 or 3 mm. The corolla, as in *Mentha*, is nearly equally four-lobed, the upper lobe being a little broader than the others, and the lower a little longer. The stigma is exserted about one mm. The hermaphrodite flowers are proterandrous, the anthers being exserted from one to two mm.

As far as noted, *Lycopus sinuatus* blooms from Aug. 5 to Sept. 16. On Aug. 13, 25 and Sept. 7, the following list of insects was observed, all only sucking except No. 4:—

Diptera — *Empidæ:* (1) Empis sp.; *Syrphidæ:* (2) Chrysogaster nitida Wd.; (3) Mesograpta marginata Say; (4) Syritta pipiens L., s. & f. p.; *Tachinidæ:* (5) Siphoplagia anomala Twns.; (6) Ocyptera euchenor Wlk.; (7) Trichopoda pennipes F.; (8) Jurinia smaragdina Mcq., ab.; *Dexidæ:* (9) Scotiptera parvicornis Twns. (MS); *Sarcophagidæ:* (10) Sarcophaga sp.; (11) Lucilia cornicina F.

Hymenoptera — *Apidæ:* (12) Apis mellifica L. ♀; (13) Bombus virginicus Oliv. ♀; *Andrenidæ:* (14) Prosopis affinis Sm. ♂; *Philanthidæ:* (15) Eucerceris zonatus Say; *Sphecidæ:* (16) Ammophila sp.; (17) Isodontia philadelphica Lep.; *Scoliidae:* (18) Myzine interrupta Say.

Lepidoptera — *Rhopalocera:* (19) Pholisora catullus F.

Coleoptera — *Lampyridæ:* (20) Chauliognathus pennsylvanicus DeG.

As in the case of *Mentha Canadensis*, the list shows a preponderance of diptera, in which it agrees with Müller's list of *L. europæus*, as shown in the table.

	DIPTERA.	HYMENOP. TERA.	OTHER INSECTS.		
Lycopus europæus — Low Germany — Müller	6	1	3	....	10
sinuatus — Illinois	11	7	2	....	20

Pycnanthemum lanceolatum Ph. — The stems rise from 5 to 11 dm., the flowers being crowded in large flat-topped, compound inflorescences and being fertilized by insects which crawl about over them. In the Botanical Gazette, XIII, 154, Foerste gives a good account of the flowers, noting the proterandry, the little importance of the Labiate form and the great variety of insect visitors. The Labiate character of the

flowers has little importance, except as a record of a former condition. The flowers are erect or nearly so, and the lips are so widely expanded that the stamens are fully exposed and the tubes are about equally accessible from any side. Then the flat-topped inflorescence forms a most convenient resting-place for insects which would find great difficulty in visiting the flowers if they were widely separated.

From his observations on the American *P. lanceolatum* and *pilosum* in the Berlin garden, Dr. E. Löw * arrives at the erroneous conclusion that they are specially adapted to diptera. He found a plant with female flowers, from which it appears that the genus has gynodiœcious species. Later, Meehan records † the occurrence of gynodiœcism in *P. muticum*.

The tubular portion of the corolla is about 5 mm. long, and nectar rises in the tube so as to become accessible to tongues which cannot drain it. It blooms from July 14 to Sept. 7. July 31, the following list was observed, all the insects sucking: —

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, ab.; (2) Heriades carinatum Cr. ♀; (3) Cœlioxys 8-dentata Say ♀; (4) Epeolus remigatus F.; (5) E. lunatus Say ♀, freq.; (6) Calliopsis andreniformis Sm. ♂♀; *Andrenidæ:* (7) Nomia nortoni Cr. ♂; (8) Agapostemon radiatus Say ♂, ab.; (9) Augochlora lucidula Sm. ♂♀; (10) Halictus pectoralis Sm. ♀; (11) H. similis Sm. ♂; (12) H. parallelus Say ♀; (13) H. lerouxii Lep. ♂♀, (14) H. ligatus Say ♀; (15) H. faciatus Nyl, ♂♀, ab.; (16) H. confusus Sm. ♂♀, ab.; (17) H. stultus Cr. ♂, freq.; (18) Sphecodes arvensis Pttn. ♂♀, ab.; *Eumenidæ:* (19) Zethus spinipes Say; (20) Odynerus dorsalis F.; (21) O. arvensis Sauss.; (22) O. foraminatus Sauss.; *Crabronidæ:* (23) Oxybelus emarginatus Say; *Philanthidæ:* (24) Eucerceris zonatus Say, freq; (25) Cerceris fumipennis Say; *Sphecidæ:* (26) Ammophila procera Klug, ab.; (27) A. vulgaris Cr.; (28) A. pictipennis Walsh; (29) A. gracilis Lep.; (30) A. intercepta Lep.; *Scoliidæ:* (31) Myzine 6-cincta F.; (32) M. interrupta Say; (33) Scolia bicincta F.

Diptera — *Bombylidæ:* (34) Exoprosopa fasciata Mcq; (35) E. fascipennis Say; *Conopidæ:* (36) Zodion fulvifrons Say; (37) Oncomyia loraria Lw.; *Syrphidæ:* (38) Sphærophoria cylindrica Say; (39) Eristalis tenax L.; (40) Syritta pipiens L.; *Tachinidæ:* (41) Hyalomyia robertsonii Twns.; (42) Trichopoda pennipes F.; (43) Cistogaster occidua Wlk.; (44) Jurinia apicifera Wlk., ab.; (45) Acroglossa hesperidarum Will., freq.; *Muscidæ:* (46) Compsomyia macellaria F., freq.

* Beiträge z. Kentniss d. Bestäubungseinrichtungen einiger Labiaten, 1886.

† Proc. Acad. Nat. Sci. Phil., 1890.

Lepidoptera — *Rhopalocera:* (47) Pieris protodice B.-L.; (48) Phyciodes tharos Dru., freq.

Coleoptera — *Rhipiphoridæ:* (49) Rhipiphorus limbatus F.

Hemiptera — *Lygæidæ:* (50) Lygæus turcicus F.

Pycnanthemum muticum Pers. var. *pilosum* Gray. — Compared with the preceding, the plant is less abundant, has taller stems, 5 to 13 dm., and the inflorescences are hardly as attractive to insects, being somewhat smaller and less flat-topped. The tubes are about 6 mm. deep, only about one mm. deeper than in *P. lanceolatum*, but the result is that *P. muticum* shows more bees, compared with other hymenoptera, and an increase in large and long-tongued diptera. The plant blooms from July 5 to Aug. 15. July 29–31 I observed the following insects, all only sucking honey, except Nos. 17 and 18:—

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, ab.; (2) Bombus americanorum F. ☿; (3) Ceratina dupla Say ♀; (4) Megachile brevis Say ♀; (5) Epeolus lunatus Say ♂; (6) Calliopsis andreniformis Sm. ♂♀, freq.; *Andrenidæ:* (7) Agapostemon radiatus Say ♂, ab.; (8) Augochlora lucidula Sm. ♂♀; (9) Halictus pectoralis Sm. ♀; (10) H. similis Sm. ♂♀; (11) H. parallelus Say ♀; (12) H. lerouxii Lep. ♂♀, very ab.; (13) H. ligatus Say ♂♀, ab.; (14) H. fasciatus Nyl. ♂♀, ab.; (15) H. pilosus Sm. ♀; (16) H. zephyrus Sm. ♀; (17) H. confusus Sm. ♂♀, s. & c. p., ab.; (18) H. stultus Cr. ♀, s. & c. p., ab.; (19) Sphecodes mandibularis Cr. ♂; (20) S. arvensis Pttn. ♂♀; (21) Prosopis affinis Sm. ♀; *Eumenidæ:* (22) Odynerus foraminatus Sauss., ab.; (23) O. anormis Say; (24) O. sp.; *Crabronidæ:* (25) Crabro interruptus Lep.; (26) Anacrabro ocellatus Pack.; *Philanthidæ:* (27) Eucerceris zonatus Say; *Bembecidæ:* (28) Monedula carolina F.; *Sphecidæ:* (29) Ammophila procera Klug; (30) A. vulgaris Cr.; (31) A. intercepta Lep.; (32) A. pictipennis Walsh, freq.; (33) A. gracilis Lep., freq.; (34) Sphex ichneumonea L.; *Pompilidæ:* (35) Priocnemis fulvicornis Cr.; *Scoliidæ:* (36) Myzine sexcincta F., ab.; (37) M. interrupta Say; (38) Scolia bicincta F., ab.

Diptera — *Bombylidæ:* (39) Exoprosopa fascipennis Say, ab.; *Conopidæ:* (40) Physocephala tibialis Say; (41) Zodion fulvifrons Say; (42) Oncomyia loraria Lw.; *Syrphidæ:* (43) Eristalis tenax L.; (44) E. dimidiatus Wd.; (45) E. transversus Wd.; (46) Syritta pipiens L., ab.; *Tachinidæ:* (47) Hyalomyia purpurascens Twns.; (48) Trichopoda pennipes F.; (49) Cistogaster pallasii Twns.; (50) Jurinia smaragdina Mcq.; (51) J. apicifera Wlk., ab.; (52) Acroglossa hesperidarum Will.; (53) Siphona illinoensis Twns.; (54) Cuphocera ruficauda v. d. W.; *Sarcophagidæ:* (55) Sarcophaga sp.; *Muscidæ:* (56) Stomoxys calcitrans L.; (57) Lucilia cæsar L.; (58) Compsomyia macellaria F.

Lepidoptera — *Rhopalocera:* (59) Pieris protodice B.-L.; (60) Phyciodes tharos Dru.

Coleoptera — *Rhipiphoridæ:* (61) Rhipiphorus limbatus F.

Pycnanthemum linifolium Ph.—In my neighborhood this is the most common species of the genus. The stems are shorter than in *P. lanceolatum*, growing from 4 to 7 dm. high. The corolla tubes are a little shorter, about 4 mm. long. It was observed in bloom from June 29 to Sept. 12. July 19 and 20 I collected the following visitors, all only sucking, except No. 12:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, ab.; (2) Melissodes bimaculata Lep. ♂; (3) Ceratina dupla Say ♀; (4) Phileremus illinoensis Rob. ♀; *Andrenidae:* (5) Augochlora humeralis Pttn. ♀; (6) A. lucidula Sm. ♀; (7) A. pura Say ♀; (8) Halictus pectoralis Sm. ♀; (9) H. lerouxii Lep. ♂♀; (10) H. parallelus Say ♂♀; (11) H. fasciatus Nyl. ♂ ♀; (12) H. confusus Sm. ♀, s. and c. p.; (13) H. pruinosus Rob. ♂; (14) Sphecodes arvensis Pttn. ♀; (15) Prosopis affinis Sm. ♂♀; (16) P. pygmaea Cr. ♀; *Eumenidae:* (17) Odynerus arvensis Sauss.; (18) O. foraminatus Sauss.; *Crabronidae:* (19) Crabro interruptus Lep.; *Philanthidae:* (20) Eucerceris zonatus Say; *Bembecidae:* (21) Monedula ventralis Say; (22) M. 4-fasciata F.; *Sphecidae:* (23) Ammophila intercepta Lep.; (24) A. gracilis Lep.; (25) Pelopoeus cementarius Dru.; (26) Isodontia philadelphica Lep.; (27) Priononyx atrata Lep.; (28) P. thomae F.; *Pompilidae:* (29) Pompilus philadelphicus Lep.; (30) P. marginatus Say; (31) P. ferrugineus Say; *Scoliidae:* (32) Myzine sexcincta F.; (33) M. interrupta Say.

Diptera — *Midasidæ:* (34) Midas clavatus Dru.; *Bombylidæ:* (35) Exoprosopa fascipennis Say; *Empidæ:* (36) Empis clausa Rob. (MS); *Conopidæ:* (37) Conops brachyrrhynchus Mcq.; (38) Physocephala texana Will.; (39) Zodion fulvifrons Say; (40) Oncomyia lorarla Lw.; *Syrphidæ:* (41) Chrysogaster nitida Wd.; (42) Mesograpta marginata Say; (43) Sphaerophoria cylindrica Say; (44) Eristalis latifrons Lw.; (45) E. transversus Wd.; (46) E. vinetorum F.; (47) Syritta pipiens L.; *Tachinidæ:* (48) Cistogaster occidua Wlk.; (49) C. pallasii Twns.; (50) Jurinia smaragdina Mcq.; (51) J. apicifera Wlk.; (52) Acroglossa hesperidarum Will.; *Muscidæ:* (53) Lucilia cornicinaF.; (54) Compsomyia macellaria F.

Lepidoptera — *Rhopalocera:* (55) Pieris rapae L.; (56) Colias philodice Godt.; (57) Phyciodes nycteis D.-H.; (58) Pyrameis huntera F.; (59) Lycaena comyntas Godt.

Coleoptera — *Scarabæidæ:* (60) Trichius piger F.; *Cerambycidæ:* (61) Typocerus sinuatus Newm.; *Mordellidæ:* (62) Mordella 8-punctata F.; (63) M. marginata Melsh.; *Rhipiphoridæ:* (64) Rhipiphorus flavipennis Lec., in cop.; (65) R. limbatus F., ab.

Hemiptera — *Lygaeidæ:* (66) Lygaeus turcicus F.; (67) Oncopeltus fasciatus Dall.

Pycnanthemum lanceolatum & linifolium — The following is a mixed list of insects taken from the flowers of both species and containing insects not mentioned in the lists of either of them: —

Hymenoptera — *Apidæ:* (1) Bombus separatus Cr. ♂♀; (2) B. pennsylvanicus DeG. ♀; (3) B. americanorum F. ♀; (4) B. virginicus Oliv. ♀; (5) Megachile inimica Cr. ♀;(6) M. latimanus Say ♂♀; (7) M. mendica Cr. ♂♀, ab.; (8) M. petulans Cr. ♂; (9) M. brevis Say ♂♀, ab.; (10) Alcidamea producta Cr. ♀; (11) Cœlioxys alternata Say ♂♀; (12) Epeolus fumipennis Say ♂; (13) Nomada texana Cr. ♀; *Andrenidæ:* (14) Halictus forbesii Rob. ♀; *Eumenidæ:* (15) Odynerus anormis Say; (16) O. sp.; *Crabronidæ:* (17) Crabro ruffifemur Pack.; (18) Oxybelus frontalis Rob.; *Philanthidæ:* (19) Philanthus ventilabris F.; (20) Cerceris sp.; (21) C. finitima Cr.; *Bembecidæ:* (22) Megastizus brevipennis Walsh; (23) Bembex nubillipennis Cr.; (24) B. fasciata F.; *Larridæ:* (25) Astata unicolor Say; (26) Tachytes validus Cr.; *Sphecidæ:* (27) Sphex ichneumonea L.; (28) S. pennsylvanica L.; *Pompilidæ:* (29) Priocnemis fulvicornis Cr.

Lepidoptera — *Rhopalocera:* (30) Colias cæsonia Stoll; (31) Junonia cœnia Hüb.; (32) Thecla humuli Harr.; (33) Chrysophanus thoe B.-L.; (34) Pholisora catullus F.; *Ctenuchidæ:* (35) Scepsis fulvicollis Hub.

Diptera — *Bombylidæ:* (36) Anthrax fulvohirta Wd.; *Conopidæ:* (37) Conops xanthopareus Will.; (38) Physocephala tibialis Say.

Coleoptera — *Rhipiphoridæ:* (39) Rhipiphorus dimidiatus F.; *Curculionidæ:* (40) Centrinus scutellum-album Say.

Hemiptera — *Pentatomidæ:* (41) Euschistus ictericus L.; *Capsidæ:* (42) Calocoris rapidus Say — all sucking.

Hedeoma pulegioides Pers. — On stems which rise 1 or 2 dm. the pale-purplish flowers are arranged in small axillary clusters, one or two being open in each cluster at a time and being obscured by the abundant leaves.

The corolla measures about 7 or 8 mm., the tube 6, its narrow part 4. The lower lip, which is 3 lobed and expands about 3 mm., is marked with purple. The upper lip is straight, two-lobed and forms an imperfect helm. Two stamens alone are perfect, their anthers being exerted.

The flowers are imperfectly proterandrous or homogamous, and cross or self-pollination may occur.

The flowers are evidently adapted to small bees, and appear to depend mainly on *Calliopsis andreniformis* Sm. ♂♀, which is an abundant visitor. They are also visited by *Augochlora pura* Say ♀. The plant is common and blooms from Aug. 7 to Sept. 12.

Monarda Bradburniana Beck.—This horse-mint is common in "thickets, Illinois to Tennessee and Kansas," and with *Scutellaria parvula* is one of the earliest of Labiatæ,

blooming from May 17 to June 18. The plants are often collected in conspicuous patches. The stem rises 3 to 6 dm. and bears a large terminal head of pale purplish flowers.

The corolla is about 40 mm. in length and is divided for about half its length into strongly divergent lips. The upper lip is linear and measures about 20 mm. in length. Below, it is folded over the style and filaments; at tip it is provided with a beard the significance of which will be explained below. The lower lip is oblong and deeply channelled above — the groove forming a guide for the proboscides of the visitors. This lip is ornamented with purplish dots. The two anthers are situated under the tip of the upper lip, but are very feebly sheltered by it. The stigma is several mm. in advance of the anthers; its upper lobe is nearly aborted, the lower is long and curled downwards when receptive.

The flowers are proterandrous, but if the anthers retain some of their pollen until the stigma is receptive, spontaneous self-pollination is impossible on account of the wide separation of anthers and stigma. The flowers may be pollinated by insects with pollen from flowers of the same or of distinct plants.

The upper lip is slightly arched over the lower one; then the anthers, when dehiscent, and the stigma in turn when receptive, bend a little downwards so as to be more likely to touch the back of an insect settling upon the lower lip, but the lips still remain so strongly divergent that a consideration of the floral mechanism and the varying conditions in the relations of the visitors becomes exceedingly interesting.

At its origin, the upper lip is nearly perpendicular to the axis of the lower. Their tips are about 20 mm. or more apart. The dehiscent anthers and receptive stigma stand about 10 mm. above the highest part of the lateral edge of the lower lip. It is evident that only the largest insects are likely to touch these organs while resting upon the lower lip. The tube measures about 18 mm., its upper part being wide enough to admit the head of a bumble-bee for about 5 mm. This also indicates an adaptation to large insects with long tongues. The early blooming of the flower is also significant, for at this time the female bumble-bees, which are much larger than the

males and workers, are abundant, while the workers are just beginning to appear. Accordingly, I regard the flower as adapted to bumble-bee females, which in fact are the most abundant visitors. But butterflies and humming-birds are also frequent and are efficient pollinators. The visitors mentioned below were observed on 8 days, between May 19 and June 7:—

Apidæ: (1) Bombus separatus Cr. ♀, s., freq.; (2) B. americanorum F. ♀, s., ab.; (3) B. virginicus Oliv. ♀, s., one, rarely touching anthers and stigma; (4) B. ridingsii Cr., ♀, s. and c. p., one.

Trochilidæ: (5) Trochilus colubris L.

Rhopalocera: (6) Pyrameis huntera F.; (7) Papilo philenor L.; (8) Pamphila zabulon B.-L., v. quadriquina Scud.; (9) P. metacomet Harr.; (10) Eudamus pylades Scud.; (11) E. bathyllus S.-A. — all sucking.

Now the tube, although 18 mm. deep, admits small bees for about 7 mm. and the nectar rises as high as 11 mm., so that small long-tongued bees can lower the nectar several mm., although not able to drain the tube. As a consequence, the nectar is often sought by small, or medium sized insects which never, or rarely, touched the anthers and stigma. Examples of such intruders are:—

(12) Apis mellifica L. ♀, s., ab.; (13) Ceratina dupla Say ♀, s. and c. p., ab.; (14) Coelioxys rufitarsis Sm. (=dubitata Sm.) ♀, s., one; (15) Bombylius atriceps Lw., s., ab.

In addition to these, a number of small bees visit the flower only for pollen, alighting directly upon the anthers or upon the tip of the upper lip, whose hairs serve them as a foot-hold while collecting pollen. These bees only find what they seek when the flower is in the male stage, but since they can hardly tell that the pollen is gone until they have landed, they are quite apt to visit the flowers which are in the female stage also. As they approach the tip of the lower lip from below and in front, they are apt to strike the stigma before they land. At any rate, I am satisfied that they often effect cross-pollination and that the hairs on the tip of the lip are increased in number and size for their benefit. The case is interesting, since it shows how the flower might be enabled to dispense with its nectar-visitors and depend upon its pollen-visitors—either if the nectar-visitors should become unnec

essary, or if they should become extinct, or rare, or should be drawn away by the competition of other flowers. The abundance of pollen-visitors is a result of the exposure of the anthers so that bees can land upon them or in a position convenient for reaching them. I think that *Verbascum* has become a synacmic pollen-flower as a result of exposing its anthers in such a way that they were sought so abundantly by pollen-insects that the nectar and the insects attracted by it became of no importance. To this third set of insects, in which *Ceratina dupla* (13) must be included, belong the following:—

(16) Calliopsis parvus Rob. ♀; (17) Augochlora pura Say ♀, ab.; (18) Halictus 4-maculatus Rob. ♀; (19) H. pectoralis Sm. ♀; (20) H. coriaceus Sm. ♀; (21) H. forbesii Rob. ♀; (22) H. confusus Sm., ♀, all c. p.; (23) Prosopis affinis Sm. ♂, f. p.

Finally, the flowers are perforated by *Odynerus foraminatus* Sauss., which being unable to obtain the nectar in a legitimate way, reaches it by cutting holes in the tube.

Monarda fistulosa * L. — The plant is very common, often growing in large patches along roadsides. It resembles the preceding, but is taller and much branched, the branches terminated by large heads, which rise to nearly the same level and render the plant quite conspicuous. The heads are smaller than in *M. Bradburiana*, about 45 mm. across, the flowers being of a uniform rose color.

The corolla measures about 30 mm. to the tip of the upper lip, the lower lip being about 12 mm. The upper lip is narrow, is continued directly upwards in line with the axis of the tube and seems to be of little or no value as a protection to the anthers and stigma, since these parts surpass its tip. The anthers and stigma stand 12 mm. distant from the lower lip and are hardly bent towards it, so that only the largest bees are likely to touch them when landing upon the lip.

On account of the erect position of the flowers, the exposure of the anthers and stigma, and the crowding of the flowers in an almost flat-topped cluster, the irregularity of the corolla

* See Foerste: Bot. Gaz. XIII, 154.

has little significance. Indeed, it seems that a return to complete regularity would not seriously disturb the present insect relations of the flower. Insects can land indefinitely upon the head, approach the flowers with equal convenience from almost any side, and can receive the pollen on almost any part of their bodies.

The tubes measure 18 or 19 mm., which indicates an adaptation to long tongues. The form of the tube, the bilabiate corolla, and the positions of the stamens and style indicate that the flower is a modification of a *nototribe* flower originally adapted to bumble-bees. The level-topped heads, the erect corollas, the exposed organs and the rose color indicates a tendency to suit butterflies, which in fact are the principal guests.

I have found the flowers in bloom from July 9 to Sept. 19. On 19 days, July 16 – Aug. 28, I observed the following visitors:—

Lepidoptera — *Rhopalocera:* (1) Papilio philenor L., ab.; (2) P. asterias F., ab.; (3) P. troilus L.; (4) P. cresphontes Cram.; (5) Colias philodice Godt.; (6) Danais archippus F.; (7) Argynnis cybele F.; (8) Limenitis disippus Godt.; (9) Pamphila zabulon B.-L.; (10) P. peckius Kby.; (11) P. otho S.-A., v. egeremet Scud.; (12) Pholisora hayhurstii Edw.; (13) Eudamus bathyllus S.-A.; (14) E. tityrus F.; *Sphingidæ:* (15) Hemaris thysbe F.

Birds — *Trochilidæ:* (16) Trochilus colubris L.

Hymenoptera — *Apidæ:* (17) Bombus vagans Sm. ♀; (18) B. americanorum F. ♂♀☿, ab.; (19) B. pennsylvanicus De G. ♂♀☿, ab; (20) B. separatus Cr. ♂, ab.; (21) Melissodes comanche Cr. ♂; (22) M. bimaculata Lep. ♀ .

Diptera — *Bombylidæ:* (23) Exoprosopa fasciata Mcq., freq. — all sucking

In addition to the above, which visit the flowers only for nectar, which they obtain in a legitimate way, the flowers are sometimes sought by small bees in search of pollen, as in the case of *M. Bradburiana.* In this case I have observed: (24) Ceratina dupla Say ♀; (25) Halictus confusus Sm. ♀, ab.

The corollas are even more abundantly perforated by the same wasp, (26) Odynerus foraminatus Sauss., and by (27) O. dorsalis F. To obtain the nectar these wasps always cut new holes at the base of the tube, apparently never using the old holes. After this comes a lot of insects which do not cut holes themselves, but take advantage of the holes cut by

the *Odynerus*. In this category I have observed: (28) Apis mellifica L. ♀, ab.; (24) Ceratina dupla Say ♀; (29) Agapostemon radiatus Say ♀; (30) Augochlora pura Say ♀; (31) Halictus ligatus Say ♀; (32) H. lerouxii Lep. ♀; (33) H. fasciatus Nyl. ♀; (34) H. pilosus Sm. ♀; (25) H. confusus Sm. ♀; (35) Ammophila pictipennis Walsh.

Blephilia ciliata Raf. — The stems rise from 3 to 6 dm. and are simple, or sparingly branched, the stems and branches each bearing 3 or 4 head-like whorls, which measure about 3 cm. across.

The corolla is pale-purplish, the lower lip dotted with purple. The upper lip is narrow and commonly reflexed, forming a very imperfect helm. The lower lip is wider, 3-lobed, the middle lobe being long and narrow. The stamens are two, their anthers being exposed in the throat of the corolla. The anthers discharge their pollen before the stigma is receptive. The style becomes strongly exserted, holding the receptive stigma far beyond the upper lip. Sometimes plants are found having flowers with aborted anthers, which shows that the species is gynodiœcious.

On account of the exposure of the anthers and stigma and their close approximation, the flowers are so degraded that they have little advantage over regular, erect flowers. If these organs were protected, the flower would dust the back of each visitor in a very precise manner. As it is, insects crawl over the heads in an indefinite way, readily pollinating flowers which they do not visit. If the flowers were widely separated, insects like *Ammophila* would hardly visit them.

The corolla tube measures about 8 mm. and is, therefore, evidently adapted to long tongues, especially bees. On account of the exposed situation of the anthers, the flower is also visited for pollen by small bees which cannot drain the tubes, although they may reach some of the nectar which rises in them.

The plant is common in dry grounds and blooms from June 1 to July 3. On 8 days, between June 2 and 22, I collected the following visitors: —

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, s., ab.; (2) Bombus virginicus Oliv. ♀, s.; (3) B. americanorum F. ♀, s.; (4) B. pennsylvanicus DeG. ♀, s.; (5) B. separatus Cr. ♀, s.; (6) Ceratina dupla Say ♀, s. and c. p., ab.; (7) Megachile montivaga Cr. ♁, s., freq.; (8) M. brevis Say ♂♀, s. and c. p.; (9) M. mendica Cr. ♂♀, s.; (10) Alcidamea producta Cr. ♀, s. and c. p.; (11) Andronicus cylindricus Cr. ♂, s.; (12) Heriades carinatum Cr. ♀, s. and c. p., freq.; (13) Osmia distincta Cr. ♀, s.; (14) Cœlioxys 8-dentata Say ♂, s.; (15) Calliopsis andreniformis Sm. ♂♀, s.; *Andrenidæ:* (16) Agapostemon nigricornis F. ♀, s. and c. p., ab.; (17) Augochlora pura Say ♀, s.; (18) Halictus fasciatus Nyl. ♀, s. and c. p.; (19) H. pilosus Sm. ♀, s. and c. p.; (20) H. confusus Sm. ♀, s. and c. p., ab.; (21) H. stultus Cr. ♀, s. and c. p., freq.; *Sphecidæ* (22) Ammophila procera Klug., s., ab.; (23) A. intercepta Lep., s.; (24) A. pictipennis Walsh, s.; (25) Prionony x atrata Lep., s.

Lepidoptera — *Rhopalocera:* (26) Pieris protodice B.-L.; (27) P. rapæ L.; (28) Colias philodice Godt.; (29) Danais archippus F.; (30) Argynnis cybele F.; (31) Pamphila cernes B.-L.; (32) P. manataaqua Scud.; (33) P. verna Edw.; (34) Eudamus tityrus F. — all sucking.

Diptera — *Bombylidæ:* (35) Anthrax parvicornis Lw.; (36) Bombylius atriceps Lw., ab.; (37) Toxophora amphitea Wlk.; *Empidæ:* (38) Empis clausa Rob. (MS); *Tachinidæ:* (39) Jurinia smaragdina Mcq.; (40) Epigrimyia polita Twns. — all s.

Coleoptera — *Scarabæidæ:* (41) Trichius piger F., s. and f. p., freq.

Blephilia hirsuta Benth. — This species closely resembles the preceding, but is less abundant, grows in damp woods, the stems being taller, 7 to 10 dm., more branched, the heads smaller, about 2 cm. wide and somewhat more widely separated. The flowers are white, the lower lip dotted with purple. The latter is expanded horizontally, with broad lateral lobes and a narrow median one. The upper lip is narrow and has lost its function as a helm, the anthers and stigma projecting far beyond it. At first the stamens hold the dehiscent anthers above the tip of the upper lip. After the pollen is discharged, they fall forwards, and the receptive stigma takes their place.

The flowers are often visited by bees which land upon the lower lip, suck the nectar in a legitimate way and receive the pollen upon their backs; but the exposure of the anthers and stigma makes it easy for bees to transfer the pollen by crawling over the heads in an indefinite way and sucking the flowers from any side, or even not sucking them at all. The exposure of the anthers makes it easy for small bees to collect the pollen, and they may do harm by neglecting the flowers in the

female stage, though they may pollinate them while crawling over the head in search of pollen.

As in *B. ciliata* the tubes are about 8 mm. long. On account of its shady situation, the plant is not so abundantly visited as in the preceding, and the list shows some peculiarities: viz., the scarcity of butterflies and the abundance of *Stylogaster*. On account of the later time of blooming — June 21 to Sept. 3 — the list shows males of *Bombus*, *Augochlora* and *Halictus*. On 7 days, between June 26 and July 21, I noted the following list: —

Hymenoptera—*Apidae:* (1) Apis mellifica L. ♀, s.; (2) Bombus virginicus Oliv. ♂, s.; (3) B. ridingsii Cr. ♂, s., freq.; (4)Ceratina dupla Say ♀, s. and c. p., ab.; (5) C. tejonensis Cr. ♂, s.; (6) Heriades carinatum Cr. ♀, s. and c. p.; *Andrenidae:* (7) Agapostemon nigricornis F. ♀, s., freq.; (8) A. radiatus Say ♀, s. and c. p.; (9) Augochlora pura Say ♂♀, s. and c. p.; ab.; (10) A. labrosa Say ♀, s.; (11) A. lucidula Sm. ♂, s.; (12) Halictus 4-maculatus Rob. ♀, c. p.; (13) H. pectoralis Sm. ♀, c. p.; (14) H. lerouxii Lep. ♂, s.; (15) H. pilosus Sm. ♀, s.; (16) H. stultus Cr. ♀, c. p., ab., (17) Prosopis affinis Sm. ♀, f. p.; *Sphecidae:* (18) Ammophila vulgaris Cr., s.

Diptera—*Empidae:* (19) Empis clausa Rob (MS); *Conopidæ:* (20) Stylogaster neglecta Will. s., very ab.; *Syrphidæ:* (21) Allograpta obliqua Say, f. p.; (22) Syritta pipiens L., f. p., sev.; *Muscidæ:* (23) Stomoxys calcitrans L., s.

Lepidoptera—*Rhopalocera:* (24) Pieris protodice B.-L.

Lophanthus nepetoides Benth. — The flower is figured and described by Foerste, in Am. Nat. XVIII., 928. The corolla is greenish-yellow. The stamens and style are exserted as far as 3 mm. beyond the corolla, so that the anthers and stigma are entirely unprotected by it. The stamens are strongly divergent. While the anthers are discharging pollen, the style is bent upwards, but afterwards it bends downwards, so as to hold the receptive stigma near the axis of the flower.

The stem and branches are terminated by close spikes in which the flowers are crowded. The flowers are visited by insects crawling over them, as Foerste has observed, and since the organs are exserted, the visitor is dusted indefinitely on all sides, and not on the back as would be the case if the flower had not lost its *nototribe* character.

On one occasion I found, at the summit of a spike, a flower with five stamens of equal length. The corolla showed

no sign of irregularity, except that one lobe, the lower, was a little longer than the other four. The ovary had four cells. The style was straight, holding the stigma directly over the center of the flower. The calyx was normal, but there was a well developed pedicel 2 mm. long. The flower had a slight inclination toward the lower petal.

The tube of the corolla is about 7 mm. long. The visitors consist mainly of bees. The plant is common, growing from one to two metres in height, and blooming from Aug. 4 to Sept. 22. On 7 days, between Aug. 7 and Sept. 2, I observed the following list:—

Hymenoptera — A*pidæ:* (1) Apis mellifica L. ☿, s., ab.; (2) Bombus vagan Sm. ♂, s., freq.; (3) B. virginicus Oliv. ☿, s. and c. p., ab.; (4) B. americanorum F. ♂☿, s. and c. p., ab.; (5) Melissodes bimaculata Lep. ♀, s.; *Andrenidæ:* (6) Augochlora labrosa Say ♀, s.; (7) Halictus confusus Sm. ♀, c. p.; (8) H. stultus Cr. ♀, c. p., ab.; *Sphecidæ:* (9) Ammophila intercepta Lep., s.

Diptera — *Bombylidæ:* (10) Exoprosopa fasciata Mcq., s.; *Syrphidæ:* (11) Mesograpta geminata Say, f. p.; (12) Syritta pipiens L., s. and f. p.

Lepidoptera — *Rhopalocera:* (13) Danais archippus F.; (14) Pieris rapæ L. — both s.

Plants transferred from their normal habitat to the Berlin garden were found by Löw (l. c.) to be visited by *Coritus parumpunctatus* Schill. and *Lebirus biguttatus* L. He also found *L. rugosus* visited by *Apis mellifica*, *Bombus sp.*, *Eristalis tenax*, *Syritta pipiens* and *Coritus parumpunctatus*.

Lophanthus scrophulariæfolius Benth. — This species agrees essentially with the preceding. The anthers are purplish and the corolla purplish tinged. The tubes are about 6 mm. long. Aug. 3 the following visitors were noted: —

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, s., freq.; (2) Bombus pennsylvanicus DeG. ☿, c. p.; (3) B. americanorum F. ☿, s. and c. p.; (4) Megachile mendica Cr. ♀, s.

Diptera — *Bombylidæ:* (5) Exoprosopa fasciata Mcq., s., freq.

Nepeta Cataria L. — "Nat. from Eu." — The Catnip is common along road-sides and in waste-places. The stamens are tall, much branched, and the flowers are crowed in spike-like clusters. The flowers are proterandrous. The corolla tube is about 5 mm. deep, so that short-tongued bees can reach some of the nectar and those with mid-length tongues

can exhaust it. There is no list of the insects which visit it in its native country, Müller having observed only *Bombus muscorum* as a visitor.* It has succeeded in acquiring an efficient set in this country, as the following list indicates. It blooms from June 19 to Oct. 24. The list was made out on ten days, between June 26 and Sept. 10.

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, ab.; (2) Bombus virginicus Oliv. ☿; (3) B. americanorum F. ☿; (4) Melissodes bimaculata Lep. ♀; (5) Ceratina dupla Say ♀; (6) Megachile rufimanus Rob. ♂♀, ab.; (7) M. pugnata Say ♂; (8) M. relativa Cr. ♀; (9) M. infragilis Cr. ♂; (10) Alcidamea producta Cr. ♀; (11) Heriades carinatum Cr. ♀; (12) Nomada incerta Cr. ♀; (13) Calliopsis andreniformis Sm. ♀; *Andrenidæ:* (14) Agapostemon radiatus Say ♀; *Vespidæ:* (15) Odynerus fulvipes Sauss.; (16) O. foraminatus Sauss.

Diptera — *Bombylidæ:* (17) Anthrax parvicornis Lw.; *Tachinidæ:* (18) Jurinia smaragdina Mcq.; (19) J. apicifera Wlk.

Lepidoptera — *Rhopalocera:* (20) Pieris protodice B.-L.; (21) P. rapæ L. (22) Pyrameis atalanta L. — all sucking.

Nepeta Glechoma † Benth. (Glechoma hederacea L.) — "Nat. from Eu." — The flowers bloom before any of our native Labiates and, accordingly, show quite a peculiar set of visitors. The plant grows in damp woods, the stems being prostrate or procumbent. There are two or three blue flowers in the axils of the leaves, in which situation they are quite inconspicuous. The corolla approaches the typical Labiate form, the stamens and pistil being protected by a well developed galea. The pollen is dusted very definitely upon the tops of the heads of bumble-bee females, which are the normal visitors, or upon the upper part of the thorax of small bees. Butterflies occur as intruders, being quite uncertain to touch the anthers and stigma. The list shows a striking resemblance to the German list observed by Müller, the species being replaced by American species of the same genera. The genera *Synhalonia*, *Alcidamea*, and *Augochlora*, being American, could not occur as visitors in the normal habitat. Müller observed *Bombus* workers in Germany, but I observed only females. I have found only the female form, with tubes 8 or 9 mm. long.

* Alpenblumen.

† See Müller; Fertilization of Flowers.

The flowers are open from April 7 to June 21. On 6 days, between Apr. 28 and May 20, I observed as visitors: —

Hymenoptera — *Apidæ*: (1) Apis mellifica L. ♀, ab.; (2) Bombus vagans Sm. ♀; (3) B. ridingsii Cr. ♀; (4) B. americanorum F. ♀; ab.; (5) B. fervidus F. ♀, two, the only specimens I have seen here; (6) Anthophora abrupta Say ♂♀, ab.; (7) Synhalonia speciosa Cr. ♂♀, ab.; (8) Ceratina dupla Say ♂♀, ab.; (9) Alcidamea producta Cr. ♂; (10) Osmia albiventris Cr. ♀, freq.; (11) Nomada superba Cr. ♀, freq.; *Andrenidæ:* (12) Augochlora pura Say ♀; (13) A. lucidula Sm. ♀.

Diptera — *Bombylidæ:* (14) Bombylius atriceps Lw., ab.; *Syrphidæ:* (15) Rhingia nasica Say.

Lepidoptera — *Rhopalocera:* (16) Pieris rapæ L.; (17) Colias philodice Godt., ab.; (18) Pamphila zabulon B.-L.; (19) P. peckius Kby.— all sucking.

	Apis.	Bombus.	Anthophora.	Synhalonia.	Ceratina.	Alcidamea.	Osmia.	Nomada.	Andrena.	Halictus.	Augochlora.	Bombylius.	Rhingia.	Eristalis.	Lepidoptera.	To al.
Low Germany — Müller	1	11	1	..	..	..	3	1	3	1	.	2	1	1	4	28
Illinois	1	4	1	1	1	1	1	1	..	..	2	1	1	..	4	19

Scutellaria parvula Mx. — This is one of the earliest blooming of indigenous Labiates. The plants are scattered, or sometimes collected in thin patches. The stems rise 2 or 3 dm. The flowers are solitary in the axils of the opposite leaves, so that they appear in pairs. When several flowers are open at the same time they seem to be arranged in loose spikes.

The corolla measures about 9 mm., the tube being about 7 mm. and so wide above that it readily admits the head of a small bee for about 3 mm. The lower lip measures 5 mm. across and is directed downwards, forming the most attractive part of the flower. The corolla is blue, the lower lip being marked by a large squarish white spot dotted with purple and with streaks above leading into the throat.

The upper lip includes the lateral lobes. The upper lobe is only large enough to cover the anthers. The result is that the mode of pollen contact is of the most definite sort, the anthers touching the upper part of the bee's head and thorax. The lateral lobes are folded inwards under the anthers, so that a bee only touches them when the lateral lobes are

forced apart. This leaves the passage into the tube between the infolded lateral lobes and the lower one.

The anthers are approximated in pairs under the upper lip, the stigma occupying the interval between them. The foremost pair of anthers have only one cell, which is turned towards the receptacle. The outer cell is aborted, and the anther is turned so that the pollen-bearing cell is concealed. The aborted cell is bearded. When a bee enters, it strikes this anther and turns its face even further out of position for pollen contact, but when it withdraws, if it touches the beard, the anther is rotated downwards so as to bring the pollen surface in contact with the bee's body. This mechanism prevents the bee from carrying pollen back from the anthers to the stigma of the same flower. Consequently, if the bee enters with pollen from another flower, it will dust it upon the stigma before touching the pollen of the flower.

The flowers appear homogamous and are probably self-pollinated in absence of insects. They are adapted to small long-tongued bees, like *Ceratina* and *Alcidamea*. Butterflies are useless intruders, since they can drain the tubes without transferring pollen. The plants are common and bloom from May 20 to June 29. On 5 days, between May 19 and June 3, I observed as visitors: —

Hymenoptera — *Apidæ:* (1) Ceratina dupla Say ♂♀, s., ab.; (2) Megachile brevis Say ♂, s.; (3) Alcidamea producta Cr. ♂♀, s. and c. p., very ab.; (4) Osmia 4-dentata Cr. ♀, s.; (5) O. albiventris Cr. ♀, s. and c. p.; *Andrenidæ:* (6) Halictus pectoralis Sm. ♀, s.; (7) H. ligatus Say ♀, s.; (8) H. pilosus Sm. ♀, s.; (9) H. tegularis Rob. ♀, s., freq.; (10) H. pruinosus Rob. ♀, s., freq.;

Lepidoptera — *Rhopalocera:* (11) Ancyloxypha numitor F., s.; (12) Pamphila peckius Kby., s.; (33) Pholisora catullus F., s., freq.

Diptera — *Syrphidæ:* (14) Sphærophoria cylindrica Say, f. p.; (15) Syritta pipiens L., f. p.

Scutellaria canescens Nutt. — The stems are 6 to 12 dm. high and are terminated by a conspicuous flower-cluster formed by the closely collected racemes. The flower is like that of the preceding, but is much larger. The middle lobe of the upper lip is closely folded over the stamens and style, like the keel of *Papilionaceæ*. The flower is nearly closed, so that, when the bee forces an entrance, the galea is pushed upwards

and the organs are exposed. Afterwards, they return into the galea. The flowers are proterandrous. Two lateral lobes of the upper lip and two streaks on the lower are white, forming pathfinders. The tubes are about 14 mm. deep. The flower seems to depend mainly upon our common long-tongued bumble-bee, *Bombus americanorum* F. ☿, which visits it for honey and pollen. It is also visited for honey and pollen by *B. virginicus* Oliv. ☿, and for honey by *Exoprosopa fasciata* Mcq. and by *Pamphila zabulon* B.–L.

On Aug. 7, I noticed three little bees, *Augochlora pura* Say ♀, *Halictus confusus* Sm. ♀ and *H. stultus* Cr. ♀, sucking at holes near the base of the tube on one side. I suspected that the perforator was *Odynerus foraminatus* Sauss., the same insect which perforates the flowers of *Monarda fistulosa* and *Bradburiana* and *Pentstemon lævigatus*. After waiting awhile I was rewarded by seeing this wasp return to the plants and cut several new holes. As in the cases above, I only noticed the insect making new holes and not using the holes already made.

This plant was observed on 4 days, between Aug. 3 and 26. It is common and blooms from July 11 to Sept. 19.

Scutellaria versicolor Nutt. — The stems rise from 3 to 6 dm. and bear a few racemes of blue flowers. The lower lip is white dotted with purplish. The corolla is about 19 or 20 mm. long, its tube being narrow and measuring about 15 or 16 mm. Pollen is dusted upon the upper side of the bee's head. There are only a few flowers open on each plant at a time, so that, although crossing between flowers of the same plant may occur, it is much more likely to be between flowers of distinct plants. The flower is visited by *Anthophora abrupta* Say. It is common and blooms from June 20 to July 15.

Brunella (*Prunella*) *vulgaris* L. — "Fields and borders of copses, Newfoundland to Florida, and west to California and northward; evidently indigenous in some of the cooler districts. (Eu. Asia, Mex.)"— The flowers approach the typical form, the anthers being protected by the galea.

They are purplish and are arranged in a verticillastrate-spicate or capitate inflorescence. They are adapted to bumble-bees, although often visited by other long-tongued bees and by butterflies. The plant blooms from July 6 to Oct. 9. On 8 days, between July 11 and Sept. 2, the following list was observed: —

Hymenoptera — *Apidæ:* (1) Bombus virginicus Oliv. ♂ ♀ ; (2) B. separatus Cr. ♂; (3) B. vagans Sm. ♀ ; (4) B. americanorum F. ♀, ab.; (5) Clisodon terminalis Cr. ♂ ♀ ; (6) Melissodes bimaculata Lep. ♀ ; (7) Ceratina dupla Say ♀ ; (8) Megachile mendica Cr. ♂ — all s. ; *Andrenidæ:* (9) Augochlora pura Say ♀, s.; (10) Halictus fasciatus Nyl. ♀, c. p.; *Scoliidæ:* (11) Scolia bicincta F., s.

Lepidoptera — *Rhopalocera:* (12) Pieris rapæ L.; (13) P. protodice B. L.; (14) Colias philodice Godt.; (15) Pamphila peckius Kby.; (16) P. cernes B.-L.; (17) P. otho S. and A., var. egeremet Scud.; (18) Pholisora hayhurstii Edw. — all s.

Diptera — *Bombylidæ;* (19) Exoprosopa fasciata Mcq.; *Tachinidæ:* (20) Jurinia smaragdina Mcq. — both s.

The following table gives the results of the observation of *Brunella vulgaris* in widely separated localities: —

	Bombus.	Other Apidæ.	Andrenidæ.	Scoliidæ.	Butterflies.	Diptera.	
In Low Germany — Müller	4	3	3	....	5	....	15
On the Alps — Müller	5	....	....	....	10	1	16
On the Pyrenees — MacLeod	7	....	....	....	....	2	9
In Illinois	4	4	2	1	7	2	20

Physostegia Virginiana Benth. — This is by far the most handsome of the native Labiates, blooming from July 19 to Oct. 10. The stems rise from 5 to 10 dm., being terminated by one simple spike or by several spikes collected in a panicle. The flowers are cataleptic,* so that when turned in any direction they remain in the same position until disturbed. Prof. J. M. Coulter † has observed that this movement is of advantage in a driving rain by turning the mouths of the flowers away from the rain. As pointed out in the Bot. Gaz. XIII.,

* See Bailey: Bot. Gaz., VII., 122.
† *Ibid.* 111.

33, the movement is also of advantage in windy weather, since bees as a rule move against the wind and always turn with their heads towards it when alighting, so that the movement of the flowers turns them in such a position that the bees are most likely to be attracted by their odor and color, and can readily land upon them.

The flowers are rose or flesh-color, measure about 25 mm. long and, when collected in the spikes, make a splendid display. The Labiate form is somewhat modified by the enlargement of the mouth of the tube, which admits the head and thorax of a bumble-bee. The anthers and stigma are protected under the upper wall, and the pollen is dusted upon the upper part of the bee's thorax. The proterandry of the flower was first recorded by Delpino.*

The narrow part of the tube is about 9 mm. long. The flower is visited abundantly and almost exclusively by *Bombus americanorum* F. ♂♀☿. I have also seen it visited by single individuals of *Melissodes bimaculata* Lep. ♂, *Megachile brevis* Say ♂, *Danais archippus* F. and *Colias philodice* Godt. At Mt. Carmel, in Southern Illinois, according to Schneck, Bot. Gaz. XVI., 312, the flower is perforated by *Xylocopa virginica*. This bee is rare in my neighborhood; I have never seen but two individuals.

Marrubium vulgare † L.—"Nat. from Eu."—The corolla is white, the upper lip narrow and cleft, the lower three-lobed. The stamens are included in the corolla tube, so that they are out of reach of pollen-insects, and the pollen is applied to the insect's proboscis. The tube is about 5 mm. long.

In Germany, Müller found the flowers visited by 4 bees, 1 Chrysid, 1 Empis, 1 bug, 1 beetle. In the Pyrenees, MacLeod saw it visited by *Bombus terrestris*. The flowers bloom from May 28 to Oct. 5. June 22, 29, and Sept. 9, I observed the following visitors:—

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ☿, ab.; (2) Bombus ameri-

* Ulteriori osservazioni.
† See Müller: Weit. Beobachtungen.

canorum F. ♀; (3) Ceratina dupla Say ♀; (4) Megachile brevis Say ♀, one.

Diptera — *Bombylidæ:* (5) Bombylius atriceps Lw.

Lepidoptera — *Rhopalocera:* (6) Pieris protodice B.-L., freq. — all s.

Leonurus Cardiaca L. — "Nat. from Eu." — This plant is common, growing along side-walks and road-sides. The stems rise 5 to 10 dm. and with the nearly erect branches, bear many whorls of flowers which appear as if arranged in a long leafy spike. Only a few flowers are open at a time in each whorl.

The corolla is whitish, the upper lip being pale purplish beneath and the lower being marked with brownish and purple. The lips are strongly divergent. The lower has the middle lobe folded and the lateral strongly reflexed. The upper lip is oblong and somewhat galeate, protecting the dehiscent anthers. Later, when the stigma becomes receptive, the upper lip is reflexed.

The flower is properly fertilized by bees in search of honey, and the pollen is applied to their backs. But small bees, like *Halictus*, collect the pollen, hanging to the strongly bearded upper lip while doing so. They no doubt neglect the flowers in the second stage, although they may sometimes effect pollination by alighting upon the style and stamens after the galea becomes reflexed. The flowers bloom from June 8 to Oct. 18. June 15 and 22 the following list of visitors was observed: —

Hymenoptera — *Apidæ:* (1) Apis mellifica L. ♀, s., ab.; (2) Anthophora abrupta Say ♂, s.; (3) Ceratina dupla Say ♀, s. and c. p., freq.; *Andrenidæ:* (4) Halictus fasciatus Nyl. ♀, c. p.; (5) H. confusus Sm. ♀, c. p., ab.; (6) H. stultus Cr. ♀, c. p.

Diptera — *Syrphidæ:* (7) Syrphus ribesii L.; (8) Mesograpta geminata Say; (9) Allograpta obliqua Say — all feeding on stray pollen.

At Wood's Holl, Mass., in July, Professor Trelease saw the flowers visited by (1) Apis mellifica L. ♀; (10) Bombus virginicus Oliv, ♀; (11) B. americanorum F. ♀; (12) Pieris rapæ L.

In Europe, where the plant is indigenous, Müller found it visited by Apis and four species of Bombus.*

* Weit. Beobachtungen and Alpenblumen.

*Stachys palustris** L. — "Wet ground, Newfoundland to the Pacific in Oregon, south to Penn., and in the Rocky Mountain region to N. Mexico, north to Mackenzie River (Eu., N. Asia)" — The stem grows from2 to 10 dm. high. The flowers are arranged in whorls of six or more in the axils of the upper leaves, the uppermost whorls being approximated in loose spikes. Spikes of this kind terminate the stem and several branches, so that the flowers are rendered quite conspicuous and attractive to insects.

The corolla is pale purplish, measuring about 11 mm. long. The upper lip forms a well-developed helm, which serves as an efficient protection for the anthers. The helm is 4 mm. long and 3 mm. wide. The lower lip affords a convenient horizontal landing place about 6 mm. in extent, with large lateral lobes and a larger rounded middle one.

The flowers are proterandrous. In the first stage the flowers are less expanded, so that the visiting insects are more likely to touch the anthers. In the second stage the flower is more widely expanded, but then the receptive stigma is exserted considerably beyond the helm and is held down towards the lower lip in such a position that it is apt to touch a bee as it alights. From the mode of development of the flowers, visiting insects are most likely to approach the lower flowers first, proceeding upwards to those discharging pollen, which they carry in turn to the lower receptive flowers of the next spike.

Pollination may occur between different flowers of the same plant on different spikes. Cross-pollination occurs between distinct plants when the bee changes plants. I have not been able to satisfy myself that spontaneous self-pollination takes place, though Müller states that it does.

The flower shows the normal melittophilous form and function of the typical Labiates, although it is sometimes visited by flies and lepidoptera. On account of the protection of the helm, the pollen is not easily collected by *Halictus*, which neglect the flowers with receptive stigmas. It is accurately applied to the backs of insects sucking the honey. The tubes are from 6 to 8 mm. long, which indicates an adaptation to long

* See Müller: Fertilization of Flowers.

or mid-length tongues, but rather short tongues can reach the nectar by forcing their heads into the throat. The plant blooms from June 22 to Oct. 7. The visitors observed on 9 days, between June 23 and Aug. 29, are as follows: —

Hymenoptera—*Apidæ:* (1) Bombus americanorum F. ♂♀, s., freq.; (2) B. vagans Sm. ♀, s.; (3) Anthophora abrupta Say ♂, s.; (4) Melissodes bimaculata Lep. ♂♀, s., freq.; (5) Ceratina dupla Say ♀, s., ab.; (6) Meg gachile brevis Say ♀, s., ab.; (7) Alcidamea producta Cr. ♀ , s. and c. p., freq., (8) Calliopsis andreniformis Sm. ♂, s.; *Andrenidæ:* (9) Agapostemon nigricornis F. ♀, s.; (10) Halictus confusus Sm. ♀, c. p.

Lepidoptera—*Rhopalocera:* (11) Ancyloxypha numitor F.; (12) Pamphila cernes B.-L.; *Noctuidæ:* (13) Plusia simplex Gn., in the evening—all s.

Diptera—*Bombylidæ:* (14) Systœchus vulgaris Lw., s.; *Syrphidæ:* (15) Syrphus ribesii L., f. p.; (16) Mesograpta marginata Say, f. p.

	BOMBUS.	OTHER APIDÆ.	ANDRENIDÆ.	DIPTERA.	LEPIDOP-TERA.	
Stachys silvatica — Low Germany — Müller...	3	3	....	2	....	8
Pyrenees — MacLeod.....	1	....	....	....	....	1
recta — Alps — Müller.....	4	....	....	....	....	4
Low Germany "	....	2	....	....	....	2
Pyrenees — MacLeod.....	2	....	....	....	1	3
Betonica — Low Germany — Müller...	3	3	....	2	5	13
palustris — " " " ...	4	1	....	2	3	10
Illinois.....	2	6	2	3	3	16

Review of the Labiatæ. — As in the case of *nototribe* flowers in general, I suppose that the form from which the original ancestor of the Labiatæ was developed was a regular horizontal gamopetalous flower in which insects were prevented from alighting upon the stamens by a tube which concealed them. The insects were thus required to land upon the lower border and to enter the flower on the lower side, touching the anthers and stigma with their backs and inserting their proboscides into the lower side of the tube. Consequently, the flower has become modified to suit an insect entering in this way. In the typical Labiate flower we find two lips, an upper one forming a helm protecting the anthers and stigma, and a lower forming a landing-place for visiting insects, as well as being the principal attractive organ. Below these is the contracted tube serving to lodge and conceal the nectar.

The ancestral type was probably melittophilous and has produced a most numerous set of species in competition with one another for the attention of bees. Competition between allied species is most severe. As a result of this strong competition we have many forms which have so far changed from the original type that they no longer come in competition for bees, but have become adapted to other kinds of insects. In the Fertilization of Flowers, 471, Müller says: "Delpino considers *Mentha* and *Coleus* Lour., degraded forms of the Labiate type; he, however, gives no reason for thinking them to be such, and not rather less specialized forms, differing less from the common ancestors of the Labiates." *Mentha* is one of the least specialized of the family, and is specially adapted to flies. It is hardly to be expected that such a form would give rise to a large group of species nearly all of which are specially adapted to bees. Nor does it seem probable that small crowded erect flowers with exserted stamens would give rise to a multitude of flowers all of which had included stamens touching the insect's back. That *Mentha* is of a form approaching a simple regular flower is plain, but it seems to me to be a very different form from that of the original common ancester of the Labiates. It is rather a modification of a more irregular form, which I think will be more evident when we undertake to consider the forms in their divergence from the more characteristic form of Labiate flower.

It is difficult to find a flower which in its form and function realizes the type. Of those mentioned in this paper, perhaps *Scutellaria parvula* approaches the type as nearly as any, though it is probably too small. In this we have about two flowers open at a time on the leafy axis. Each flower is wholly independent of neighboring flowers. The lower lip is the main attractive part and invariably serves as a landing-place for small visitors. The anthers and stigma are concealed under the upper lip and always come in contact with the back of the insect. The nectar is concealed in a slender tube. The color is blue, with pathfinders, and the flower is adapted to bees.

The first condition which seems to be a departure from the

original type and readily to induce departures of a more serious nature is an aggregation of the flowers in a more or less close cluster. In this case the lower lip loses its distinctive function both as a vexillary organ and as a landing-place. Both offices are immediately assumed by the inflorescence itself. As long as the flowers remain separate, they attract the insects which are pleased by the special floral form and are adapted to it. But when the flowers become clustered they attract less specialized insects to what appears an undifferentiated color mass. In a similar way, separated flowers are only readily visited by insects to which the lower lip forms a convenient resting-place. But when the flowers form a compact inflorescence, a landing-place is formed by the flower-cluster. Even when the floral structure remains the same, I always expect to find less specialized insects on crowded flowers. As long as the cluster retains a spicate form, less specialized insects are not so well suited as when the inflorescence becomes flat-topped. In this case, these insects are afforded a convenient landing-place, and insects which would never notice a separate flower of the same form will rest with ease upon the broad horizontal platform afforded by the aggregated flowers.

But while the aggregation of the flowers is likely to induce the visits of less specialized insects, it makes easy other advantageous modifications correlated with the relief of the lower lip from its normal function. It permits a reduction in the size of the flower, or a contraction of its parts, with the result that the nectar may be more deeply concealed and the place of pollen-contact may become limited to the upper part of the bee's head or proboscis.

This specialization, however, is conditioned upon the retention by the galea of its normal function. For if the galea becomes reduced or reflexed in such a way as to expose the anthers and stigma, crowding results in changing the pollen-contact from the definite and precise *nototribe* style to the indefinite style characteristic of the least specialized regular flowers. If a Labiate flower typical in all other respects and separated from other flowers should come to have its anthers so exposed that insects could land upon them, it might be expected to change from *nototribe* to *sternotribe*, a

change which we may imagine has been thus produced in *Ocymum*. But exposure of the anthers and stigma in irregular crowded flowers is equally degrading both to those originally *nototribe* or *sternotribe*, — a proposition which I have already propounded in the Bot. Gazette XIII, 230.

In addition to being a most important organ in protecting the anthers and stigma and in preserving the original Labiate character of the flower, the galea, from its more or less horizontal position, also plays an important part in rendering the nectar less accessible. When, therefore, we find the flowers crowded in a flat-topped inflorescence, the upper lip reduced or reflexed in such a way as to expose the anthers and to render the nectar more accessible, we have the most degraded of the family and the form farthest removed from the type.

The fact that *Mentha* and *Pycnanthemum* have a more regular form than *Scutellaria* is no reason for supposing that it approaches the form from which the *Scutellaria* was derived. If a form like *Mentha* had its flowers exposed horizontally and separated so that each flower must be visited separately, I think it would result in *sternotribe* zygomorphism, like that of the *Papilionaceæ*, — a form almost always characterizing lateral flowers with exposed stamens. But I could hardly imagine any process by which closely crowded flowers with exposed organs would give rise to a group of flowers characterized by having the anthers protected under the upper wall of a deep tube. In the paper above referred to, I have expressed the view that small closely crowded regular flowers do not tend towards zygomorphism.

The modifications which we have considered have a most important influence in determining the kinds of insects frequenting the flowers of different species of the Labiatæ. There remains to be mentioned the varying length of the tube. In some species in which the general characters of the flower are of a low grade, a rather highly specialized set of visitors is retained as a result of a great lengthening of the tube, as in the case of *Monarda*.

In the table I have arranged the flowers as nearly as practicable in the order of their departure from the type, beginning with those which have a more perfect Labiate form, simpler

inflorescences and deep tubes and ending with those having exposed stamens, flat-topped inflorescences and short tubes. It will be observed that as the most distinct Labiate characters are lost there is an increase in the proportion of lower hymenoptera and diptera visiting the flowers. As the tubes shorten and as the galea becomes less efficient as a protecting organ, there is an increase in the number of *Andrenidæ* which visit the flower for nectar and for pollen. As we descend the list in the table, bees remain the predominant visitors until we reach *Monarda fistulosa* which shows a preponderance of butterflies. After we pass *Blephilia ciliata*, bees cease to be the predominant visitors, although the *Pycnanthemums*, except *P. linifolium*, show more bees than insects of other groups. Finally, the short tubed *Mentha* and *Lycopus* show lower hymenoptera in preponderance over bees, and flies more abundant than hymenoptera of any kind.

In the case of the Umbelliferæ, which have very uniform flowers, I have been able to show that the preponderance of bees, lower hymenoptera or diptera was determined mainly by the time of blooming, and the peculiarities in the lists of visitors were best shown by a table arranging the species in the order of blooming. A similar arrangement of the Labiatæ does not give very important results, since the differences in the lists are mainly due to differences in structure, and the time of blooming has little influence. In the case of the *Pycnanthemums*, there seems to be a plain case of correlation between the form and arrangement of the flowers and the time of flight of the lower hymenoptera, which are very important visitors. If the flowers bloomed in April, the lower hymenoptera would be almost entirely wanting, and the list would consist mainly of bees and flies.

Of the twenty-three species considered in the present paper, nine show long-tongued bees — *Bombus*, *Synhalonia*, *Anthophora* and *Melissodes* — as their principal visitors and depend mainly upon them. Eight show special adaptation to bees in general or to shorter-tongued species. Early blooming species are visited by *Bombus* females, *Anthophora*, *Synhalonia*, *Osmia* and *Alcidamea*. Later blooming species are vis-

ited by *Bombus* males and workers and *Melissodes*, while bees of the other genera are wanting.

No species is adapted to the lower hymenoptera, although 10 species were visited by them. They are important for only *Pycnanthemum*, *Mentha* and *Lycopus*. The Sphecidæ, especially *Ammophila*, are the most worthy of mention. *Ammophila* occurs as a visitor of 8 species — all after *Monarda*, except *Lophanthus scrophulariæfolius*.

Diptera occur as visitors of 19 species. Only two species, *Mentha* and *Lycopus*, are specially adapted to them. *Bombylius* occurs on four early blooming species, and *Exoprosopa* on 9 late-blooming ones, but they do not occur on the same species. Among *Tachinidæ* should be mentioned *Jurinia*, which visits 8 species.

Butterflies occur on all but five species. They are useful visitors of *Monarda Bradburiana*, and *M. fistulosa* is specially adapted to them. On other flowers they occur as intruders. *Papilio* was observed only on *Monarda*.

The ruby-throated humming-bird visits only *Monarda*. Another plant of the family, *Salvia splendens*, is specially adapted to humming birds.

Beetles occur only on the six least specialized flowers in the table. Species of *Rhipiphorus* seem to be quite fond of *Pycnanthemum*.

A few bugs occur on *Pycnanthemum*.

	BEES.	OTHER HYMENOPTERA	DIPTERA.	LEPIDOPTERA.	OTHER VISITORS.
Scutellaria versicolor	1				
" canescens	2		1	1	
Physostegia Virginiana	3			2	
Nepeta Glechoma	13		2	4	
Brunella vulgaris	10	1	2	7	
Scutellaria parvula	10		2	3	
Marrubium vulgare	4		1	1	
Stachys palustris	10		3	3	
Teucrium Canadense	4				
Leonurus Cardiaca	8		3	1	
Nepeta Cataria	14	2	3	3	
Hedeoma pulegioides	2				
Monarda Bradburiana	15		1	6	1
" fistulosa	8		1	15	1
Lophanthus nepetoides	8	1	3	2	
" scrophulariæfolius	4		1		
Blephilia hirsuta	17	1	5	1	
" ciliata	21	4	6	9	1
Pycnanthemum muticum var. pilosum	21	17	20	2	1
" lanceolatum	18	15	13	2	2
" linifolium	16	17	21	5	8
Mentha Canadensis	1	7	10	2	1
Lycopus sinuatus	3	4	11	1	1

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THE OPENING OF THE BUDS OF SOME WOODY PLANTS.

A. S. HITCHCOCK.

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THE OPENING OF THE BUDS OF SOME WOODY PLANTS.

A. S. Hitchcock.

Some notes were taken during the spring of 1892 on the opening buds of our native shrubs and trees. The drawings of the buds and leaves are mostly natural size and were made as the leaves appeared. The nomenclature and arrangement is that of Gray's Manual.

I have been unable to find any literature bearing directly upon the subject. Vernation is usually given in monographs and systematic notes, as that of *Quercus* by Engelmann, "About the Oaks of the United States," Trans. St. Louis Acad. Sci. iii., p. 375. The following are some of the references treating of bud-scales, stipules, and glands on young leaves: Goebel, Beiträge zur Morphologie und Physiologie des Blattes, 1. Die Niederblätter (Bot. Zeit. xxx, p. 753, 769, 785, 801, 817, 833; Just, viii. 1, p. 114); Schumann, Anatomische Studien über die Knospenschuppen von Coniferen und Dicotylen Holzgewächsen (Bibl. Botan. Heft. 15, 1889; Bot. Centr. xlii, 1890, No. 22, p. 275; Just, xvii. 1, p. 673); Mikosch, Beiträge zur Anatomie und Morphologie der Knospendecken Dicotylen Holzgewächse (Sietzungsb. d. kais. Akad. Wiss. Wien, B. 74, 1 Abth. 1876; Just iv, p. 453); Areschong, Beiträge zur Biologie der Holzgewächse (Lund, 1877; Just, v, p. 358); Velenovsky, Ueber die Achselsprosse einiger Smilax Arten (Flora, 68, p. 2–4; Just, xiii. 1, p. 612); C. Hilburg's Dissertation: Ueber den Bau und die Funktion der Nebenblätter, mit Zusätzen von F. Hildebrand (Flora, 1878, No. 11; Just, vi. 1, p. 105); Clos, Stipules considerées au point de vue morphologique (Bull. Soc. Bot. France, 2d Ser. i, No. 1, 1879, p. 151; Just. vii. 1, p. 69.) Reinke, Ueber die Funktion der Blattzähne und die Morphologische Werthigkeit eineger Laubblattnectarien

(Bot. Zeit. 1874, p. 47; Just, ii, p. 548). There is considerable literature relating to twigs but this is outside the subject treated in this paper.

Asimina triloba, Dunal. Buds naked, protected by the two outer, boat-shaped, dark ferruginous, silky leaves which increase but slightly in size as the bud opens, and never assume the typical shape. Inner leaves conspicuously 2-ranked, each successively inclosing the remainder of the bud. The flower buds are lateral, globose. May 3d.

Menispermum Canadense, L. Scales about 5, rounded to elliptical, smooth. Internodes above these elongating; young stem and leaves gray-villous. First leaf undeveloped, several cleft at apex, others normal. Vernation straight. Leaf-scars circular, concave. Buds 2 or 3 superposed, the upper just above the scar, the others bursting through a V-shaped crack in the leaf scar. May 6th.

Tilia Americana, L. Bud scales 2, the inner larger. Leaves well developed, each covered by its two large stipular scales. Vernation conduplicate. Apr. 30th.

Xanthoxylum Americanum, Mill. Buds low; scales two pairs, the outer pair short and dark brown, the bases of the scales joined by a circle of reddish brown fuzz; inner pair longer and their tips reddish brown with a similar pubescence. First leaf usually abnormal or abortive with two or three leaflets of unequal development, the later leaves successively better developed. Vernation of leaflets revolute, the leaf wrapping around the central cone. Apr. 29th.

Celastrus scandens, L. Buds perpendicular to axis of plant. Scales numerous, the two outer gray, like the bark, with a ridge on the back at the apex; the inner with brown tips and green bases gradually passing into leaves. Vernation involute. Apr. 29th.

Euonymus atropurpureus, Jacq. Scales opposite, two pairs. First pair of leaves small and deciduous. Vernation involute. Apr. 20th.

Ceanothus Americanus, L. Scales two to four, being rudimentary leaves with the stipules broadened and adnate to the much reduced blade. First leaf typical in form with two narrow hairy stipules. Vernation involute. Apr. 23d.

Vitis riparia, Mx. Buds rupturing the bark sometimes two superposed. Each leaf protected by its two hairy stipular scales. Vernation straight but inclosing the remainder of the bud. Apr. 1st.

Cissus Ampelopsis, Pers. Much as in *V. riparia*, but stipules and young leaves thinner and nearly smooth. May 3d.

Ampelopsis quinquefolia, Mx. Buds one to three, rupturing the epidermis. Scales four. Leaves enclosed by their enlarged stipules. First leaf perfect, 5-divided, lobes conduplicate, arranged almost in a circle. Apr. 30th.

Æsculus arguta, Buckley. Buds swelling considerably before opening. Scales opposite, six to ten pairs, the inner successively larger and thinner, but no transition to leaves. First leaves with five leaflets. Leaflets involute. Apr. 9th.

Acer dasycarpum, Ehrh. Scales opposite, four pairs; the inner pairs ciliate-margined. Vernation plicate. Apr. 21st.

Negundo aceroides, Moench. One of the first of the woody plants to show signs of pushing out leaves in spring. Scales opposite, four pairs. First pair with a roundish point; second pair about twice as long, apiculate; third pair about twice as long as the second, roundish at apex; fourth pair somewhat longer than the third, three-lobed at apex. First pair of leaves with three leaflets. Leaflets conduplicate, side by side, the margins of opposite leaves touching. Apr. 8th.

Staphylea trifolia, L. Scales opposite, two pairs. First set of stipules more than half as long as leaf, succeeding ones shorter. Leaflets involute, side by side. Apr. 22d.

Rhus Toxicodendron, L. Buds naked or occasionally with one or two scales. Leaflets conduplicate. May 5th.

Rhus Canadensis, Marsh. Buds naked, the first leaf becoming normal in size and shape. As all the internodes elongate there is but one ring separating the growth of successive years. (*R. glabra* also has naked buds, with the first leaves very felty-pubescent.) Leaves plicate. May 5th.

Amorpha fruticosa, L. Buds two, superposed, either or both developing. Scales several. First leaf pinnate, sometimes imperfect. Stipules lanceolate, acuminate. Leaflets conduplicate, side by side. May 6th.

Cercis Canadensis, L. Scales two. First leaf well-formed,

conduplicate, at first somewhat inflexed. Stipules prominent, outside of their leaf. May 2d.

Gymnocladus Canadensis, Lam. Buds at first scarcely raised above the bark; superposed, two or three, one or sometimes any two of the three developing. Scales three, enlarging greatly. First leaves with narrow stipules, pinnate below, twice pinnate above, the pinnæ ending in a bristle. Leaflets and pinnæ conduplicate. May 6th.

Gleditschia triacanthos, L. Buds superposed, usually two (one to three) both developing. Scales several, brownish, thin and soon deciduous. First leaf pinnate with several leaflets, downy beneath, smooth above; later ones twice pinnate. Stipules minute; petiole jointed with stem. Leaflets conduplicate as is the whole leaf, thus bringing the edge against the bud. May 5th.

Prunus Americana, Marsh. Scales numerous, the inner gradually increasing in length and showing a transition to the leaves. The first leaf has a pair of slender elongated stipules. Young leaves enclosing the flattened bud, the edges not overlapping, under surface silky pubescent and reticulately veined. Margin of leaf ciliate, serrations sharp and not glandular. Apr. 21st.

Prunus Chicasa, Mx. Scales as in *P. Americana*. Leaves smooth and shining, the serrations with a conspicuous gland. Young leaves enwrapping the terete bud, the edges considerable overlapping. May 4th.

Rubus occidentalis, L. Scales about six, first two rounded, with buds in their axils; next two, three pointed, the buds in their axils having well formed leaves nearly as long as scales; the inner scales are three-cleft, the lateral lobes apparently corresponding to stipules. Vernation plicate. Apr. 20th.

Rubus villosus, Ait. Scales about five, outer hard and red, pointed; inner gradually longer, rounded, hairy; fourth, 3-cleft; fifth, more deeply cleft; sixth, a small leaf. Vernation plicate. Apr. 29th.

Rosa Arkansana, Porter. Scales about seven. Outer ovate and pointed, inner becoming rounded and erose-dentate, while the innermost form a transition to leaves. Leaflets conduplicate, side by side. Apr. 20th.

Cratægus coccinea, L. Scales numerous, the inner showing a transition to leaves. The inner scales and stipules glandular ciliate, the latter being nearly as large as their leaves. Vernation conduplicate-plicate. May 14th.

Ribes gracile, Mx. Scales numerous, all but innermost scarcely enlarging. First leaf nearly normal in appearance. Vernation plicate. Apr. 11th.

Cornus asperifolia, Mx. Scales one pair, opposite, developing a small blade at the opening of the bud. Vernation slightly involute. Apr. 9th.

Sambucus Canadensis, L. Usually four buds in an axil, the central being the strongest. Scales opposite, about four pairs, showing transition to leaves. Leaflets involute, side by side. Apr. 20th.

Symphoricarpos vulgaris, Mx. Scales opposite, three pairs, increasing but little during the opening of the bud. Young leaves oval-oblong. Vernation involute. Apr. 9th.

Fraxinus viridis, Mx. f. Buds usually two, superposed. Scales opposite, one pair or if two pairs the inner hidden before the expansion of the bud. Leaflets conduplicate, side by side. Apr. 22d.

Ulmus fulva, Mx. Scales two-ranked, three or four pairs; outer dark brown and somewhat pubescent; inner silky-ferruginous above. First leaf very minute with two large stipules. Following leaves perfect, each covered by one large stipule and covering the other. Vernation conduplicate. Apr. 30th.

Ulmus Americana, L. Scales two-ranked, first three pairs empty, scarcely enlarging and soon falling off. Within these are about three pairs of stipular scales, without leaves, that is, the scales are in pairs on each side of the bud and attached at base. The next two pairs of stipules have a minute and abortive leaf between them. The inner leaves increase in size, and are imbricated with their stipules as in *U. fulva*. Vernation conduplicate. May 4th.

Celtis occidentalis, L. Scales two-ranked, three pairs. Young flowering branches bear flowers below and leaves above. Leaf branches bear above the scales two or three enlarged early deciduous stipules. First leaves normal; each enclosing its two stipules. Vernation straight. Apr. 23d.

Morus rubra, L. Scales two-ranked, six or seven. First leaf usually ovate, sometimes slightly lobed; inner ones lobed or entire. Vernation and arrangement of narrow stipules as in *Celtis occidentalis*. May 2d.

Platanus occidentalis, L. Bud conical; scales two, each covering the bud, the outer smooth, the inner covered by a gummy secretion, and usually having a bud in its axil. First leaf well formed, its stipule covering the remainder of the bud. Vernation revolute. May 2d.

Juglans nigra, L. Scales two to four, the outer oblong and obtuse, the inner increasing in length and passing by a series of clefts and lobes into a few-divided leaf. Flower buds from the lower part of the previous year's growth, usually two catkins superposed, each bearing two or three small scales at base. Leaflets conduplicate, the edges toward the rhachis and the sides pressed against the bud. May 4th.

Carya amara, Nutt. Scales two, valvate, covered with yellowish resinous dots, usually elongating and developing a few lobes at the apex. The first leaf, and sometimes the second also, is imperfectly developed. Leaflets conduplicate, side by side as shown in the drawing. May 3d.

Ostrya Virginica, Willd. Scales several, the first two are empty, the next pair are stipular with its leaf reduced to a mere appendage. The third pair is attached to a normal leaf. Vernation straight but the leaf clasping the bud. Apr. 22d.

Quercus macrocarpa, Mx. Scales stipular as in *Q. tinctoria*. The gradation is rather gradual from large stipules to narrow and from small leaves to large. Vernation conduplicate but the bend to one side of the midrib (Fig. 107). May 3d.

Quercus Muhlenbergii, Engelm. Scales numerous, five-ranked, much as in *Q. tinctoria*, but the change from broad scales to narrow ones at the base of the perfect leaves is more abrupt; thus the leaves appear to come from the top of the bud. Vernation conduplicate. May 3d.

Quercus tinctoria, Bartram. Scales very numerous, five-ranked, lower short, upper increasing in length. Several at the base are empty, above these each pair has a minute leaf in the angle between and inside, thus being stipular. The inner

leaves are successively larger and the stipules narrower. Vernation straight but the leaves are considerably corrugated. The five-ranked stipules correspond to the $\frac{2}{5}$ phyllotoxy. Young leaves very silky, purplish or pinkish. May 3d.

Salix amygdaloides, Anders. Scales two, usually splitting at the apex, the inner thin and membranous. Stipules hairy, vernation straight. Apr. 21st.

Salix cordata, Muhl. Bud is covered by one outer scale, on the inner side of which is attached the two stipular membranes which encircle the opening leaves at their base. Vernation convolute. Apr. 21st.

Populus monilifera, Ait. Scales mostly four, shining and usually gummy, outer short and rounded, inner becoming longer and more acute. First leaf normal, with two narrow stipules, purplish tinged. Vernation involute. Apr. 25th.

Smilax hispida, Muhl. Scales two, both next to the stem, that is, in the axil of the young branch and probably homologous with the sheathing stipules. Leaves involute, the first leaf bearing stipular tendrils. May 5th.

EXPLANATION OF PLATES.

1. *Asimina triloba.* Swelling lateral bud. 2. Terminal bud further advanced. 3. Cross section of bud with the two outer leaves removed.
4. *Menispermum Canadense.* Three superposed buds, the upper having developed into a branch. 5. Three buds, side view, the two upper having developed. 6. Swelling bud. 7. Young branch. 8. One of the first leaves. 9. Leaf-scar and bud before swelling.
10. *Tilia Americana.* Swelling bud. 11. Bud further advanced.
12. *Xanthoxylum Americanum.* Lateral bud developing. 13. Terminal bud further advanced.
14. *Celastrus scandens.* Lateral bud developing.
15. *Euonymus atropurpureus.* Two young lateral branches.
16. *Ceanothus Americanus.* An outer scale. 17. An inner scale. 18. A young leaf.
19. *Vitis riparia.* Swelling bud. 20. Young branch with bud below.
21. *Cissus Ampelopsis.* Young branch.
22. *Ampelopsis quinquefolia.* Swelling bud. 23. Young branch with bud below.
24. *Aesculus arguta.* Developing terminal bud.
25. *Acer dasycarpum.* Developing terminal bud.
26. *Negundo aceroides.* Developing terminal bud. 27-30. Scales showing transition to, 31. First leaf.
32. *Staphylea trifolia.* Two lateral buds developing. 33. Bud further developed, inner pair of scales removed; side view, showing two young leaves with their stipules. 34. Same, showing back of leaf.
35-36. *Rhus Toxicodendron.* Buds in different stages of development.
37. *Rhus Canadensis.* Swelling bud. 38. Developing bud. 39. Young leaf.
40. *Amorpha fruticosa.* Developing bud.
41. *Cercis Canadensis.* Developing bud. 42. Young branch.
43. *Gymnocladus Canadensis.* Swelling bud. 44. Bud further developed. 45. Young leaf.
46. *Gleditschia triacanthos.* Base of petiole of young leaf showing minute stipule. 47. Developing bud, leaves cut off above the base. 48. Young leaf.
49. *Prunus Chicasa.* Developing bud. 50-52. Young leaves. 53. Glandular serration × 125.
54. *Prunus Americana.* Developing bud. 55. Scale. 56. Inner scale or young leaf. 57. Stipule of developed leaf. 58. Serration of leaf × 125.
59. *Rubus occidentalis.* Young leaf. 60. Developing bud. 61-63. Scales.
64. *Rubus villosus.* Developing bud. 65. Young leaf. 66-68. Scales and outer leaf.
69. *Rosa Arkansana.* Developing bud. 70. Young leaf.
71. *Cratægus coccinea.* Young branch, some of the scales at base having fallen off. 72-73. Two forms of stipules on young leaves.
74. *Ribes gracile.* Developing bud.

75. *Cornus asperifolia.* Terminal bud developing. 76. Outer scale or leaf.
77. *Sambucus Canadensis.* Supernumerary buds, the uppermost developing. 78-79. Scales.
80. *Symphoricarpos vulgaris.* Developing bud.
81. *Fraxinus viridis.* Terminal bud with one pair of scales developing. 82. Bud with two pairs of scales.
84. *Ulmus fulva.* Swelling bud. 83. Bud further developed. 85. First pair of scale-like stipules.
86. *Ulmus Americana.* Swelling bud. 87. Young leaf and stipules.
88. *Celtis occidentalis.* Two young flowering branches. 89. Young leaf branch with one row of scales removed.
90. *Morus rubra.* Developing bud. 91-93. Young leaves. 94. Stipule.
95. *Platanus occidentalis.* Developing bud. 96-97. Scales. 98. Stipules of young leaf, partially unfolded.
99. *Juglans nigra.* Two flower buds with the catkins removed, showing two or three scales at base. 100. Developing leaf bud. 101. Scales and young leaf.
102-103. *Carya amara.* Buds developing.
104. *Ostrya Virginica.* Developing bud, with one leaf removed. 105 Swelling bud.
106. *Quercus macrocarpa.* Developing bud. 107. Cross section of leaf showing vernation. 108. Part of young branch showing young leaf and stipules. 109-110. Young leaves.
111. *Quercus Muhlenbergii.* Developing bud. 112. Young leaf.
113. *Quercus tinctoria.* Swelling bud. 114. Bud with outer scales removed, showing young leaf. 115. Young leaf with stipules.
116. *Salix amygdaloides.* Developing bud.
117. *Salix cordata.* Developing bud. 118. Outer scale with inner thin one attached at base, two views.
119. *Populus monilifera.* Developing bud. 120. Scales and young leaf.
121. *Smilax hispida.* Young branch. 122. Young leaf with its stipules.

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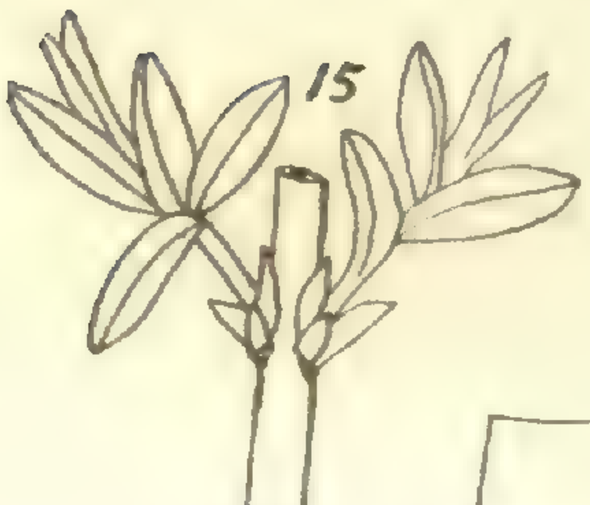
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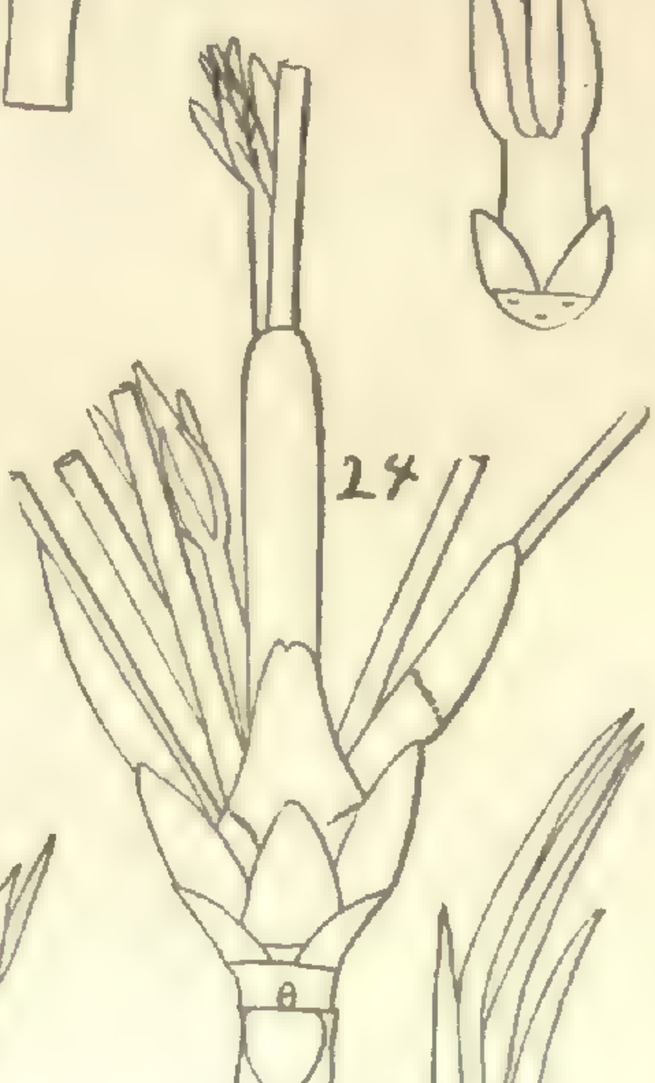
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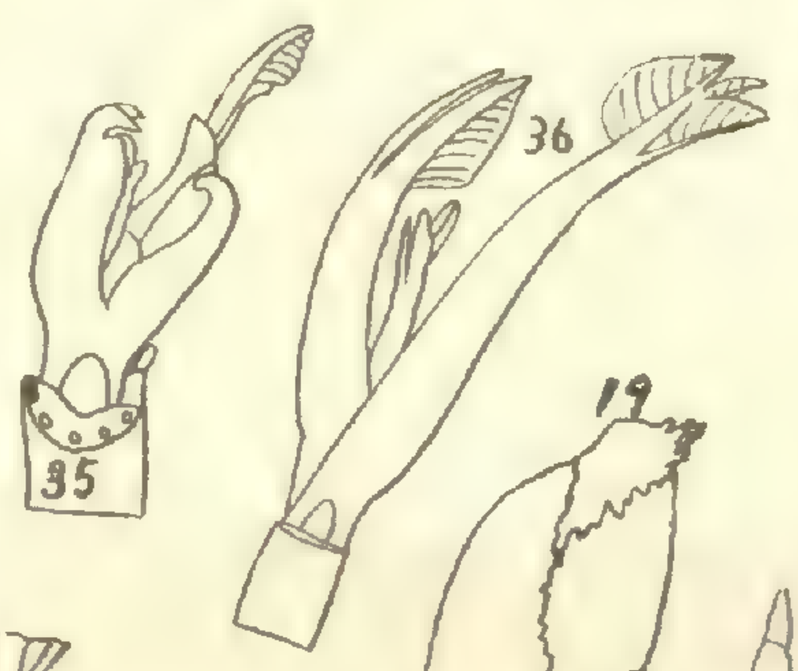
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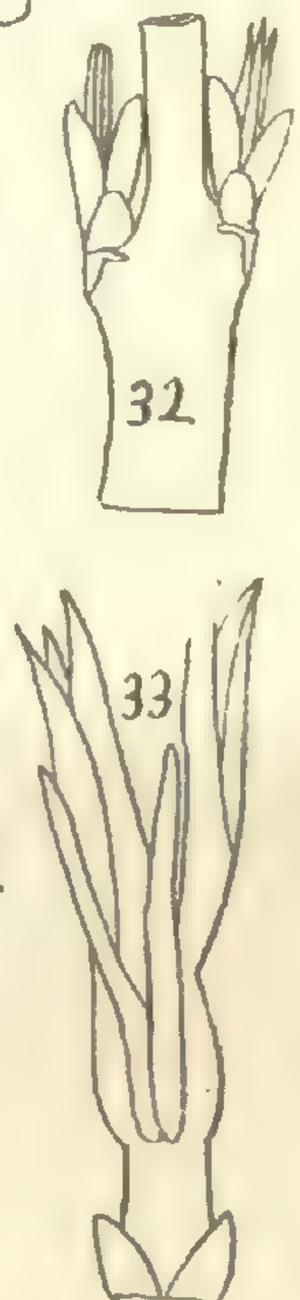
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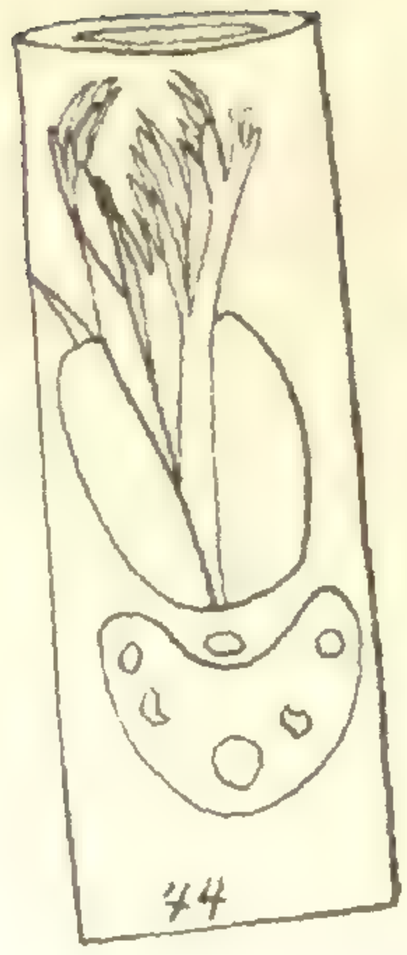

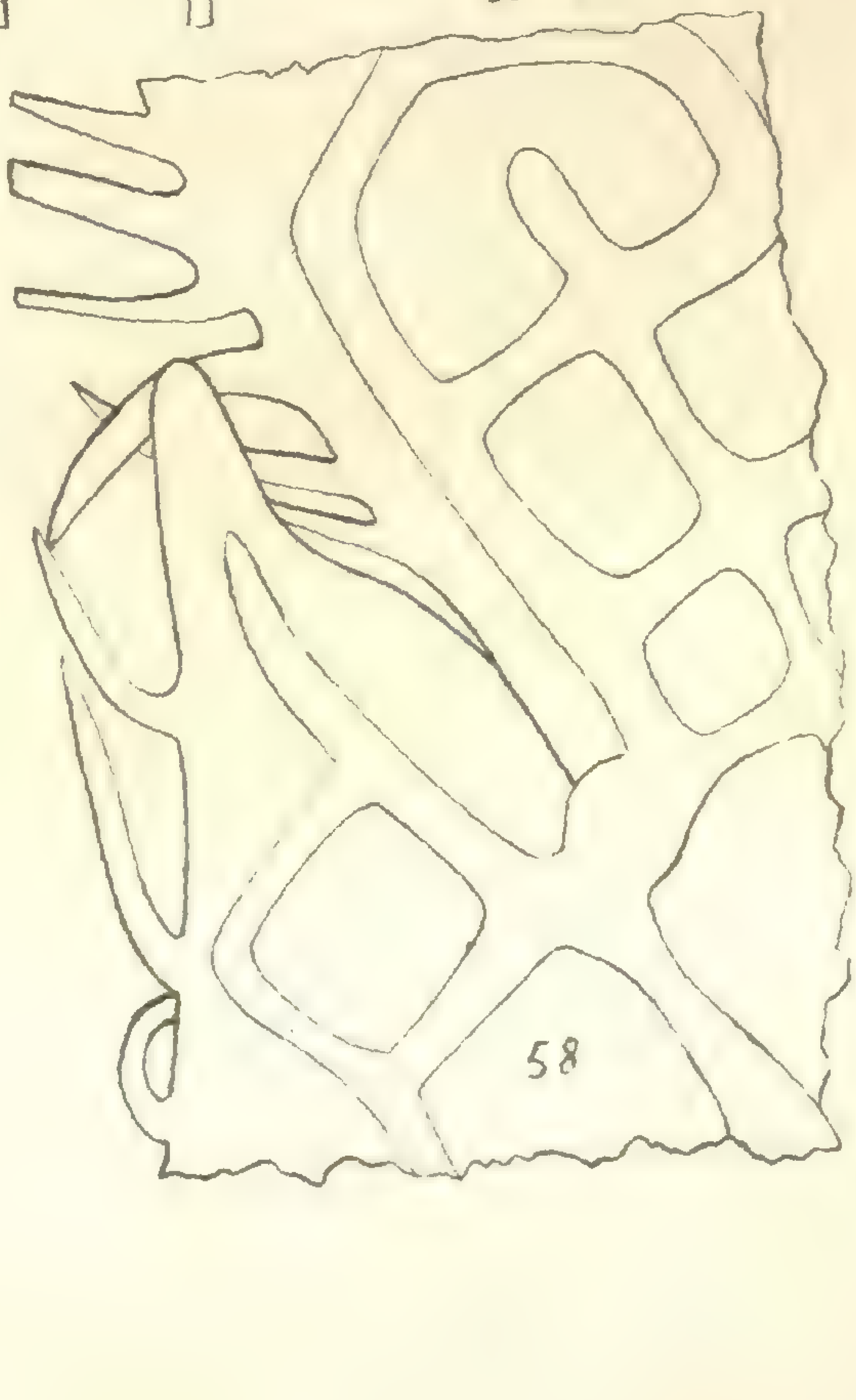

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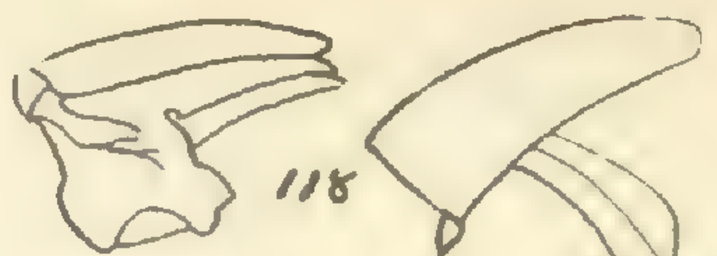
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VOL. VI. No. 6.

MATERIALS FOR A MONOGRAPH ON INULINE.

J. CHRISTIAN BAY.

Issued March 2, 1893.

MATERIALS FOR A MONOGRAPH ON INULINE.

[Contributions from the Missouri Botanical Garden. No. 1.]

J. Christian Bay.

As the knowledge of vegetable physiology proceeds it is very difficult for one man to look up all the literature on a certain subject that has been published up to date, and especially in the chemical physiology. This circumstance in connection with the fact that America is not yet provided with such extensive libraries as have been accumulated in Europe, has induced me to collect my bibliographical notes on a number of questions in vegetable physiology and to follow up the literature year by year. In a series of physiological papers from Missouri Botanical Garden I intend to publish the material for monographs on the most important questions in vegetable physiology, beginning with the chemical physiology.

These bibliographical monographs will, as far as they go, be complete up to the end of the year 1890, containing besides lists of special papers also references to the leading text and hand-books in our science. They will be of use especially for physiologists, but also for chemists; I have spent much time in making my lists as complete as possible. Most of the papers I have seen myself in the large libraries of Copenhagen, Denmark, but of course everything I could not verify.

The beginning of this series will be made with the materials for a monograph on inuline; No. 2 will contain the bibliography of the tannoids.

Reports of societies and current journals I generally abbreviate, but, in order to avoid misinterpretations, not always. In the following list the abbreviations used in this first paper will be found.

A. or L. A.=Liebig's Annalen fuer Chemie und Pharmacie.
A. de chim.=Annales de Chimie.
A. chim. phys.=Annales de Chimie et de Physique.
A. sci. nat.=Annales des sciences naturelles.
B. Z.=Botanische Zeitung.

Bull. soc. chim.=Bulletin de la société de chimie de Paris.
C. R.=Comptes Rendus hebdomadaires des séances de l'Academie Royale des Sciences.
J. de pharm.=Journal de pharmacie.
J. pr. or J. pr. Ch.=Erdmann's Journal fuer praktische Chemie.
Schweiggers Journal=Journal fuer Chemie und Physik, 1811–1833.
Sitzber. Wien.=Sitzungsberichte der k. k. Wiener—Academie der Wissenschaften. Naturwissenschaftlich-mathematische Klasse.
Trommsdorff's Journal=Journal der Parmacie, 1794-1816; 26 voll.
Trommsdorff's Neues Journal=Neues Journal, etc. 1817-1833; 27 voll.
Wiegm. Arch.=Wiegmann's Archiv fuer Naturgeschichte.
Z. f. Ch.=Beilstein's Zeitsschrift fuer Chemie.

"Pringsh. Jahrb." is a well-known abbreviation for Pringsheim's Jahrbuecher fuer wissenschaftliche Botanik. A few other abbreviations will easily explain themselves.

If either chemists or plant physiologists here or in Europe might wish to undertake the compilation of questions in the line of this series I should gladly appreciate a collaboration of this kind.

J. Chr. B.

Missouri Botanical Garden, January, 1893.

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THE PHYSICAL BASIS OF PRECOCITY AND DULLNESS.

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MISSOURI
BOTANICAL
GARDEN.

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THE PHYSICAL BASIS OF PRECOCITY AND DULLNESS.*

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In December, 1891, I received the permission of the St. Louis Board of Public Schools to collect physical measurements of the school children.

The investigation began on January 4, 1892, and was finished the fourth week in March, having extended over eleven of the fourteen weeks of winter. The weight, height, length and breadth of head, vital capacity of chest, acuteness of vision, nationality of parents, and many other facts were secured from thirty-three thousand five hundred boys and girls. The larger part of the measurements were made by the teachers, whose hearty co-operation and efficient service in this work should earn them the gratitude of every friend of science.

The great store of facts thus obtained has been used to determine the laws of normal growth of the children of St. Louis in the hope that on this firm ground may be established a system of grading which shall take into account the physical capacity of the pupil in the apportionment of school tasks. An adaptation of mental work to strength is no new idea. Many a sporadic attempt has been made to modify the standard requirements established for the average boy or girl in favor of the exceptionally weak or strong. Such efforts have rested in the past on pure empiricism. Only when the laws of growth are accurately known, is it possible to know with certainty how much the growth of an individual exceeds or falls below the normal mean, and without this knowledge the

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regulation of mental labor from a physical standpoint is a venturesome groping rather than a scientific deduction.

The rational basis for this far-reaching reform in school hygiene is fast being laid. Foreign governments are making extended anthropometric measurements of children of all ages, and in our own land private enterprise and zeal for the advancement of learning have borne the burden of investigations that should be matters of public concern. Indeed, it is an American physiologist, Henry P. Bowditch, to whom must be given the honor of having first measured weights and heights of boys and girls in numbers sufficiently large to fix with certainty the general laws of growth.

It is evident that a due regard must be paid to exceptions in the application to special classes of laws true only of the mean of all classes at each age in the period of development. The dull and the precocious constitute such special classes. It is therefore of the highest interest and importance to determine whether dullness and precocity are associated with a physical variation from the mean so palpable that it can be recognized by the coarse methods of investigation practicable in school work.

Of these methods, none is more useful than weighing, partly because it is easy to weigh and partly because the weight has a very close relation to strength. The weight in fact may be looked upon as an index of physical development. By weighing then may be answered the questions: Are dull children in the mean weaker and precocious children in the mean stronger than the average child? Is there a physical basis for precocity and dullness? Is mediocrity of mind associated in the mean with mediocrity of physique? All these questions must be answered in the affirmative, and I will now ask you to examine the method by which this answer has been reached.

The course of study in the Public Schools of St. Louis is divided into eight grades, of which the first is the lowest. To these must be added the kindergartens and the High School, including the relatively small Normal School for the training of women to be teachers. Children are admitted to the kindergartens at six years. Some pupils will be found in

the High School at age twenty-two. In the higher grades, however, the number of girls over seventeen and of boys over sixteen years of age is too small to serve as material for our present needs. My conclusions are therefore limited to twelve years in the life of girls and eleven years in the life of boys.

Within this period, children of the same age are found in several grades. Thus of 1,334 girls aged thirteen whose weight was recorded, 6 were in Grade I, and 6 in the High School, the remainder being distributed through the other grades, the greatest number (363) being in Grade IV. But here the number in the highest and lowest grades is again too small for our present purpose. For this reason, no number less than 20 has served as a basis for the calculations we are presently to consider.

The distribution of the weights of boys aged nine by School Grades is shown in Table No. 1, compiled from the forms filled out in the schools by those who weighed the pupils.

In this table the weight is expressed in pounds in the column on the left, and opposite each pound is placed the number of boys of that weight in each grade.

TABLE No. 1.

Distribution by School Grades of the weights of boys aged 9.

Grades.	I.	II.	III.	IV.	V.
Pounds.					
90	....	1	....	....	....
89	....	....	....	....	....
88	....	1	....	....	....
87	....	....	....	....	....
86	....	....	....	....	....
85	....	....	1	....	....
84	....	....	....	....	....
83	1	....	....	....	....
82	....	2	1	....	....
81	....	....	1	....	....
80	....	....	1	....	....
79	....	....	....	1	....
78	....	4	....	....	....
77	....	1	4	....	....
76	....	5	3	1	....
75	....	1	1	1	....
74	1	5	2	....	1
73	1	7	4	....	....
72	3	5	4	1	....
71	3	6	4	2	....
70	7	16	6	1	....
69	5	10	6	1	....
68	1	17	6	....	....
67	1	21	10	2	....
66	3	29	8	2	....
65	11	22	14	3	1
64	21	53	18	2	....
63	17	44	22	4	....
62	25	63	13	....	....
61	25	54	23	4	....
60	29	72	21	3	....
59	29	61	16	2	....
58	27	74	23	3	....
57	37	65	17	1	....
56	33	62	14	1	....
55	39	91	21	3	1
54	30	72	18	2	....
53	39	78	10	....	....
52	38	52	18	1	....
51	28	50	14	....	....
50	25	48	10	1	....
49	20	28	6	1	....
48	14	24	4	....	....
47	19	14	1	1	....
46	8	8	....	....	....
45	13	11	1	....	....
44	7	7	3	....	....
43	5	3	....	....	....
42	1	2	....	....	....
41	3	2	1	....	....
40	2	....	1	....	....
39	2	....	1	....	....
38	1	1	1	....	....
37	....	....	1	....	....
36	....	....	1	....	....
35	1	....	....	....	....
34	....	1	2	....	....
33	....	1	....	....	....
32	....	1	....	....	....
Total....	570	1195	357	44	3
50 p. c.....	285	597.5	178.5	22	....

The mean weight is obtained for each grade by adding the figures in the grade column, beginning at the bottom, until the sum cannot be increased by the next number without exceeding 50 per cent of the total number in the grade. This point is marked in the columns of the above table by an underscore. Somewhere in the first number above this line lies the mean of all the observations in the column. Its position may be determined by interpolation. An example will make this clear. Let us calculate the mean weight of boys of nine years in Grade II.* Fifty per cent of the 1,195 boys in this age and grade is 597.5. Adding up the column we reach 556 at 56 pounds. The next number in the column would make 621, which is more than 50 per cent of 1,195. The mean is therefore greater than 57 pounds and less than 58 pounds. The difference between 597.5 and 556 is 41.5, which is 64 per cent of 65. Thus the mean weight is 57.64 pounds.

The mean weight in pounds for each grade is printed in DOUBLE FACED type in Table No. 2 (boys), and Table No. 3 (girls), along with the number of observations (lower case type) from which each weight was calculated. The mean weight at each age irrespective of grade is also given. In Table No. 4, the weights in the two preceding tables are expressed in kilograms, the figures for boys being in DOUBLE FACED type.

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* This method is that used by Galton. See *Natural Inheritance*, London, 1889, Chapter IV.

TABLE No. 2.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis School Boys distributed by Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**43,74** 707	**43,58** 622	**45,29** 76									Pounds.
Seven	**47,73** 1814	**45,55** 534	**48,48** 1205	**52,00** 59								"
Eight	**52,58** 2188	**47,80** 28	**51,79** 1497	**54,43** 622	**57,00** 24							"
Nine	**57,75** 2188		**55,87** 570	**57,64** 1195	**59,66** 357	**61,75** 44						"
Ten	**62,48** 2064		**60,19** 207	**61,14** 789	**64,00** 766	**64,91** 269						"
Eleven	**68,47** 1644		**63,50** 59	**65,45** 311	**68,12** 664	**69,24** 546	**71,29** 123	**73,34** 33				"
Twelve	**73,61** 1242		**70,00** 28	**69,50** 104	**72,17** 430	**73,86** 602	**74,69** 306	**77,29** 141	**76,50** 22			"
Thirteen	**79,85** 946			**74,25** 38	**75,95** 149	**78,43** 352	**80,90** 336	**82,17** 229	**83,50** 78	**82,00** 34		"
Fourteen	**88,08** 498				**81,00** 46	**84,00** 184	**87,83** 194	**87,20** 242	**93,63** 143	**97,50** 88	**86,50** 25	"
Fifteen	**100,20** 203					**89,00** 26	**95,33** 58	**99,17** 125	**105,50** 103	**105,17** 93	**105,08** 51	"
Sixteen	**114,17** 71							**114,50** 25	**104,00** 23	**114,00** 60	**123,00** 66	"

TABLE No. 3.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis School Girls distributed by Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six.	**41,84** 798	**41,65** 711	**45,08** 71									Pounds.
Seven	**45,84** 1714	**43,87** 599	**46,76** 1031	**49,88** 67								"
Eight.....	**50,35** 2147	**46,50** 35	**49,60** 1408	**52,10** 643	**53,17** 45							"
Nine	**55,17** 2055		**52,57** 445	**55,44** 1175	**57,18** 365	**60,00** 48						"
Ten	**60,46** 1947		**57,00** 128	**59,59** 739	**61,15** 798	**61,64** 235						"
Eleven	**65,64** 1708		**66,34** 40	**62,95** 293	**65,50** 654	**66,77** 551	**68,12** 133					"
Twelve	**73,23** 1676		**71,75** 21	**69,80** 116	**71,50** 351	**72,74** 657	**75,13** 347	**75,92** 139	**78,50** 27			"
Thirteen.....	**83,73** 1343			**79,50** 41	**76,50** 129	**81,92** 363	**82,78** 328	**86,95** 301	**87,63** 121	**88,50** 37		"
Fourteen	**93,94** 1082				**90,50** 55	**87,17** 147	**92,67** 230	**94,64** 289	**96,15** 190	**99,00** 100	**103,12** 39	"
Fifteen	**103,20** 690					**98,50** 37	**100,96** 69	**99,83** 161	**104,00** 146	**104,58** 153	**105,15** 109	"
Sixteen.....	**110,06** 420							**108,12** 45	**107,38** 59	**110,29** 104	**113,57** 188	"
Seventeen	**115,69** 230									**111,00** 24	**116,00** 182	"

TABLE No. 4.

Age at nearest Birthday.	Mean Weights	Weights of St. Louis **BOYS** and Girls distributed by Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**19,85** 18,99	**19,78** 18,90	**20,56** 20,46									Kilograms.
Seven	**21,66** 20,81	**20,68** 19,92	**22,02** 21,23	**23,61** 22,64								"
Eight	**23,87** 22,85	**21,70** 21,11	**23,52** 22,51	**24,70** 23,65	**25,88** 24,13							"
Nine	**26,22** 25,04		**25,38** 23,86	**26,20** 25,17	**27,10** 25,96	**28,03** 27,24						"
Ten	**28,36** 27,45		**27,33** 25,88	**27,74** 27,05	**29,06** 27,76	**29,46** 27,98						"
Eleven	**31,08** 29,80		**28,83** 30,12	**29,74** 28,58	**30,92** 29,74	**31,43** 30,31	**32,41** 30,93	**33,29**				"
Twelve	**33,41** 33,25		**31,78** 32,57	**31,55** 31,69	**32,78** 32,46	**33,53** 33,02	**33,91** 34,11	**35,05** 34,47	**34,73** 35,64			"
Thirteen	**36,25** 38,00			**33,73** 36,09	**34,50** 34,73	**35,61** 37,19	**36,73** 37,58	**37,27** 39,47	**37,91** 39,78	**37,23** 40,18		"
Fourteen	**39,98** 42,65				**36,77** 41,09	**38,14** 39,57	**39,87** 42,07	**39,59** 42,97	**42,51** 43,65	**44,27** 44,95	**39,27** 46,82	"
Fifteen	**46,85** 46,85					**40,41** 44,72	**43,28** 45,83	**45,02** 45.32	**47,89** 47,22	**47,74** 47,48	**47,71** 47,74	"
Sixteen	**51,83** 49,96							**51,98** 49,09	**47,22** 48,75	**51,76** 49,69	**55,84** 51,56	"
Seventeen	52,52									50,39	52,66	"

When these tables are examined it is seen that in each age the mean weight of pupils in the higher grades is greater than the mean weight of all pupils at that age and exceeds still more the mean weight of pupils in the lower grades.* This fact is more conspicuous when the grade weights in Tables No. 2 and No. 3 are expressed graphically. The curves thus secured are reproduced in Plate I. The mean weight of all pupils at each age is marked on the curve by a small perpendicular line near the figure indicating the age. The abnormal deviation of the ends of some of the curves from the general slope of the curve is due to the number of observations at these points being too small for trustworthy results.

The truth which the curves in Plate I express is very plain. They declare in unmistakable lines that precocious children are heavier and dull children lighter than the mean child of the same age. They establish a physical basis of precocity and dullness.

Whether means or averages are the more trustworthy tools in investigations of this sort is a matter of opinion. So long as their respective value is a subject of controversy investigators will accept no results as final which can be supported only by means. It must therefore be my first concern to show that the law: MEAN PRECOCITY IS RELATED TO MEAN PHYSICAL DEVELOPMENT may with equal truth be written: AVERAGE PRECOCITY IS RELATED TO AVERAGE PHYSICAL DEVELOPMENT.

In Table No. 5 are found the average weights of boys distributed by school grades, and the average weights irrespective of grade. Pounds are in DOUBLE-FACED type and kilograms in "lower case" type. The number of observations is in each case the same as in Table No. 2.

* The end weights of the series at same age are calculated from so small a number of observations that they sometimes vary from the law which the more numerous observations toward the middle of the series show to be true.

PLATE I.

MEAN WEIGHTS OF ST. LOUIS SCHOOL CHILDREN, DISTRIBUTED BY GRADES.

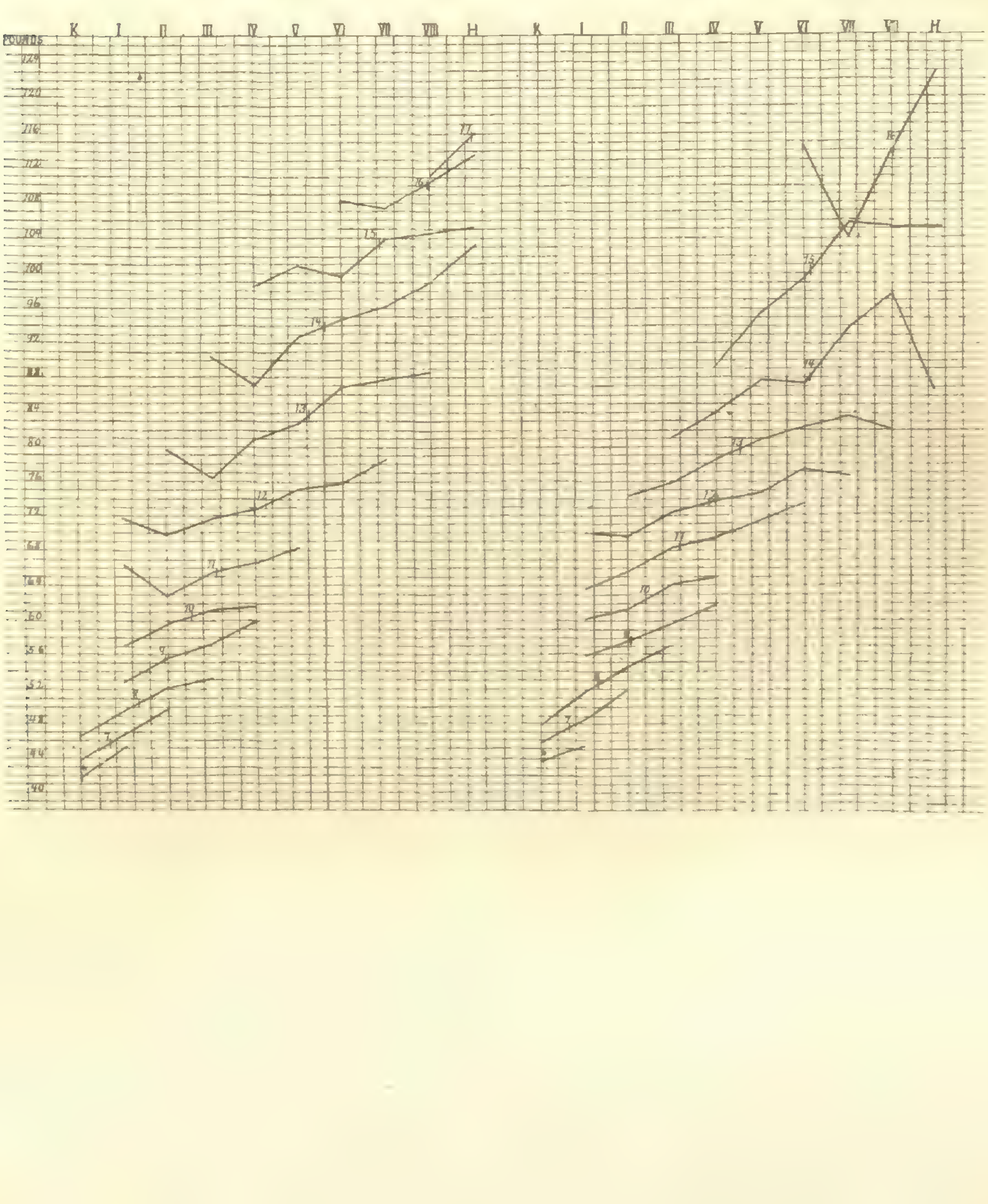

TABLE No. 5.

Age at nearest Birthday.	Average Weights	Average Weights of St. Louis School **Boys** distributed by Grades.									Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**43,49** 19,75	**43,27** 19.64	**44,99** 20,42									**Pounds** Kilogr.
Seven	**47,73** 21,67	**45,26** 20,79	**48,49** 22,01	**52,75** 23,95								**Pounds** Kilogr.
Eight	**52,39** 23,78	**48,21** 21,89	**51,58** 23,42	**54,32** 24,66	**57,33** 26,02							**Pounds** Kilogr.
Nine	**57,41** 26,06		**55,52** 25,22	**57,56** 26,13	**59,26** 26,90	**61,91** 28,11						**Pounds** Kilogr.
Ten	**62,38** 28,32		**60,36** 27,41	**61,10** 27,74	**63,57** 28,86	**64,33** 29,20						**Pounds** Kilogr.
Eleven	**68,30** 31,00		**64,22** 29.16	**65,55** 29,76	**67,77** 30,77	**71,39** 32,41	**72,37** 32,85	**74,12** 33,65				**Pounds** Kilogr.
Twelve	**73,82** 33,51			**70,63** 32,06	**71,86** 32,63	**74,31** 33,73	**75,26** 34,17	**77,83** 35,33				**Pounds** Kilogr.
Thirteen	**80,65** 36,61			**74,00** 33,60	**77,00** 34,96	**78,83** 35,79	**81,94** 37,20	**83,69** 38,00	**86,83** 39,42	**82,26** 37,33		**Pounds** Kilogr.
Fourteen	**89,09** 40,44				**84,63** 38,42	**85,59** 38,86	**90,68** 41,17	**87,75** 39,87	**93,28** 42,35	**98,22** 44,59	**91,88** 41,72	**Pounds** Kilogr.
Fifteen	**101,80** 46,22					**92,52** 42,00	**98,71** 44,81	**99,38** 45,12	**106,16** 48,20	**104,72** 47,54	**103,27** 46,88	**Pounds** Kilogr.
Sixteen	**113,65** 51,60							**116,60** 52,93	**102,00** 46,31	**114,57** 52,01	**123,77** 56,19	**Pounds** Kilogr.

This table shows that the statements in the preceding pages are supported by averages as well as means, and on this double foundation the law of the relation between precocity and physical development may well rest secure.

It is not enough to know that the mean and the average child follow this law. We must also know whether small precocious children are heavier than small dull children and on the other hand, whether large precocious children are heavier than large dull children.

To determine this we will have recourse to Galton's schemes of distribution.* If a thousand children at the same age were placed in line according to stature, the height of the middle or 500th child would be the mean (Galton's nomenclature) of the heights of the entire number. The larger children would be at one end of the line and the smaller children at the other. If we took the 300th child, counting from the middle of the line in both directions, we should have one large and one small child at an equal distance from the mean, and the weights of these children might be safely compared with the weights of children similarly selected from a series of 1,000 at another age.

A process analogous to this has been followed with the children's weights in the present instance. I have taken at each school grade and age 20 and 80 per cent of the total observations. The figures in the pound column opposite which these percentages fall represent respectively the weights of a small and a large child, and these weights may be compared with those obtained in a similar manner from other school grades and ages. Table No. 6 is made from the 20 "percentile," as Galton would call it, and thus contrasts the weight of small children in different school grades, and Table No. 7 is made from the 80 "percentile," representing the large children. In both tables, boys' weights are printed in DOUBLE-FACED type. The mean weights of small children (20 "percentile"), irrespective of school grades, are placed in the column on the left in Table No. 6 and the mean weights of large children (80 "percentile"), irrespective of school grade, occupy a similar position in Table No. 7.

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* Fully explained in Galton's *Natural Inheritance*, London. 1889. Chap. IV.

TABLE No. 6.

Age at nearest Birthday.	Mean Weights	Weights of small Boys and Girls (20 "percentile") by School Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**40,33** 38,31	**40,34** 38,22	**39,87** 40,15									Pounds.
Seven	**43,55** 41,58	**41,90** 40,00	**44,45** 42,78	**46,93** 45,23								"
Eight	**47,58** 45,46	**42,80** 41,33	**46,69** 44,87	**49,78** 47,10	**52,80** 48,00							"
Nine.....	**52,33** 49,90		**50,00** 47,64	**52,73** 50,32	**53,64** 51,46	**55,93** 52,60						"
Ten	**56,31** 53,96		**54,46** 51,30	**55,15** 52,97	**58,01** 54,43	**57,91** 57,29						"
Eleven	**61,42** 58,99		**56,60** 55,50	**59,25** 56,97	**61,20** 59,21	**63 28** 59,89	**65,66** 61,27	**65,80**				"
Twelve.....	**66,20** 64,77		**62,60** 59,50	**62,60** 61,70	**64,55** 63,77	**67,37** 64,62	**67,65** 66,78	**69,40** 67,96	**63,20** 69,60			"
Thirteen.....	**70,80** 72,79			**65,60** 71,60	**68,95** 68,64	**70,13** 70,54	**71,27** 72,93	**73,97** 75,73	**74,60** 77,44	**71,70** 77,80		"
Fourteen	**78.65** 80,90				**75,30** 77,50	**75,70** 79,23	**79,70** 81,37	**78,40** 82,18	**81,80** 84,33	**86,30** 87,67	**79,00** 87,40	"
Fifteen	**85,95** 92,09					**81,13** 83,40	**84,60** 89,80	**85,00** 89,14	**91,53** 93,40	**87,87** 95,23	**89,10** 91,40	"
Sixteen.....	**98,12** 100,50							**103,00** 94,00	**89,80** 97,40	**98,00** 101,80	**111,20** 103,94	"
Seventeen	**113,10** 105,25									**99,80**	**105,84**	"

TABLE No. 7.

Age at nearest Birthday.	Mean Weights	Weights of large Boys and Girls (80 "percentile") by School Grades.										Unit of Measurement.
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	High School.	
Six	**47,83**	**47,42**	**50,90**									
	45,92	45,71	49,95									
Seven	**52,42**	**49,46**	**53,20**	**59,20**								
	50,57	48,47	51,64	55,87								
Eight	**58,02**	**54,35**	**57,04**	**59,87**	**65,40**							
	55,71	49,75	54,73	56,92	60,00							
Nine	**63,86**		**61,84**	**63,13**	**65,40**	**70,20**						
	61,34		59,00	61,33	63,00	69,70						
Ten	**69,21**		**66,27**	**67,22**	**70,17**	**70,94**						
	67,37		63,70	65,69	68,22	69,44						
Eleven	**75,67**		**72,07**	**73,08**	**75,07**	**76,77**	**77,13**	**83,40**				
	73,93		72,50	71,55	73,77	75,48	75,77					
Twelve	**81,35**		**77,40**	**78,55**	**79,40**	**81,00**	**82,53**	**85 26**	**87,20**			
	82,97		77,60	79,80	81,35	82,87	86,65	85,20	87,20			
Thirteen	**89,90**			**80,68**	**83,70**	**87,23**	**91,56**	**93,03**	**98,35**	**89,07**		
	96,41			89,40	89,20	93,93	97,16	100,29	102,60	104,60		
Fourteen	**103,04**				**94,80**	**96,05**	**104,07**	**102,65**	**102,76**	**109,70**	**107,00**	
	107,08				105,50	104,15	105,70	108,05	106,71	112,50	108,60	
Fifteen	**117,48**					**101,20**	**110,85**	**115,50**	**120,10**	**121,10**	**119,90**	
	113,82					106,60	112,10	110,63	120,11	114,47	116,05	
Sixteen	**129,93**							**126,00**	**114,20**	**136,00**	**137,80**	
	123,00							119,00	115,20	121,40	124,80	
Seventeen	**136,93**											
	126,25									126,20	126,53	

The coincidence of high weights and high school grades so clearly demonstrated by previous tables is seen with equal clearness here. Small dull children are under, small precocious children above the mean weight of small children of their age, and the same is true of large children.

If weight is indeed a good index of physical development, it is *a priori* probable that height, girth of chest and other dimensions follow the law induced above. An analysis of the measurements at any age will show that this assumption is well grounded. Age 10, boys, and age 12, girls, may be selected for this purpose, as the number of observations at these ages is large and the pupils are found in several grades. The analysis of the height standing of boys aged 10 and girls aged 12 is seen in Tables No. 8 and No. 9 respectively.

TABLE NO. 8.

The Mean and the Average Height Standing of Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	126.50 cm.	126 13 cm.	109
II	129.39	128.78	440
III	130.29	129.96	436
IV	131.22	131.99	185
V	.....	.....	11
VI	.....	.....	3

TABLE NO. 9.

The Mean and the Average Height Standing of Girls, Aged 12.

School Grade.	Mean.	Average.	No. of observations.
I	.....	.....	14
II	136.06 cm.	135.93 cm.	73
III	139.04	138.97	217
IV	140.08	139.77	395
V	141.96	140.57	227
VI	141.90	141.80	110
VII	.....	.....	14

It appears that precocious children are taller as well as heavier than dull children.

The measurement of the girth of chest in girls is more difficult than in boys, and in both sexes is more subject to error than the measurement of weight or height. For this reason it is advisable, at least in the case of girls, to divide

the material into three groups, rather than to treat it by single grades. The result is not materially different in either method, but the means of the three large groups are more deserving of confidence than the means of the more numerous grades.

TABLE NO. 10.

Distribution of Girls, Aged 12. Girth of Chest at Forced Expiration.

School Grade.	No. of Observations.
I	13
II	68
III	204
IV	381
V	210
VI	111
VII	13
VIII	3

Grade IV, containing the greatest number of girls, is the mean grade at this age. With it may be compared the mean girth of chest of the 285 girls in grades I, II and III, and the 337 girls in the higher grades V, VI, VII and VIII. The following results appear:

TABLE NO. 11.

The Girth of Chest at Forced Expiration in Dull, Mediocre and Precocious Girls, Aged 12.

School Grade.	Mean.	No. of Observations.
I, II, III	66.21 cm.	285
IV	66.78	381
V, VI, VII, VIII	67.89	337

TABLE NO. 12.

The Girth of Chest at Forced Expiration in Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	62.96 cm.	62.62 cm.	115
II	63.27	63.11	454
III	63.94	63.81	462
IV	64.24	64.32	189
V	.....	.....	12
VI	.....	.....	3

Successful pupils have larger chests than the unsuccessful. The width of head, or distance from one parietal eminence to the other, measured with callipers, is also greater in more advanced pupils than in those less advanced.

TABLE NO. 13.

The Width of Head of Girls, Aged 12.

School Grade.	Mean.	Average.	No. of Observations.
I	.....	.....	11
II	144.25 mm.	143.68 mm.	68
III	145.52	144.77	193
IV	145.75	144.94	343
V	146.24	145.50	217
VI	148.98	147.64	89
VII	.....	.....	10
VIII	.....	.....	4

TABLE NO. 14.

The Width of Head of Boys, Aged 10.

School Grade.	Mean.	Average.	No. of Observations.
I	146.06 mm.	145.86 mm.	92
II	146.38	146.73	408
III	146.71	146.48	397
IV	147.45	147.21	170
V	.....	.....	21

NOTE.—The following information may be of interest. The classification of pupils is irrespective of nationality. The children were weighed on Fairbanks Standard Scales in indoor winter clothing. The shoes were taken off when the height standing was measured. The girth of chest was taken over the shirt in boys and over the dress in girls, in each case on a level with the nipples. The occasional corset was removed. Head measurements were made by undergraduates of the St. Louis Medical College.

So far as I am aware, the only other investigations into the relation between physical development and success in school life are recorded in the Inaugural Dissertations of Dr. Gratsianoff and Dr. Sack. Dr. Gratsianoff measured the children in Arzamas, a small town in the province of Nijni Novgorod. He claims, as I learn from the work of Sack, that successful pupils are larger than the unsuccessful and that the rate of growth is quicker in the successful. Sack (*Physical Development of the Children in the Middle Schools of Moscow*. 1892. Russian.) rejects the work of his predecessor, as founded "for the most part on a totally insufficient number of observations" (page 131). Sack's own results are derived from the examination of 4,245 boys, distributed among eight school grades; 2,600 were measured twice. Including the latter, the extent of Sack's material up to age 18 is seen in the following extract from his table on page 57:

Age.	No. Observed.	Age.	No. Observed.
7–8	1	12–13	772
8–9	13	13–14	830
9–10	76	14–15	744
10–11	450	15–16	738
11–12	671	16–17	833

No weights have been published. The author confirms Gratsianoff's

It cannot be by chance that ages ten and twelve have yielded these results, so exactly fulfilling the expectations raised by the analysis of weights. What is true of these ages is undoubtedly true of all ages in the period of development. There is no reason to apprehend that other dimensions, such as height sitting, span of arms, etc., are exceptions to the law which has been shown to exist in respect of weight, height standing, girth of chest and width of head.

We have thus far in this paper dealt with the dimensions of children of the same age. The relation between precocity and the rate of growth or yearly increase in size has not been considered, and to this most interesting subject we must now turn.

The material for the comparison of the rate of growth of dull and precocious children is found in the weights of boys and girls distributed by school grades. The manner of treating this material will be best understood by a statement of the method used in getting the weight of the mean dull and the mean precocious child at any age. Girls aged 13 may serve as an example. Their distribution by school grades is as follows:

School Grades.	No. of Observations.
I	6
II	41
III	129
IV	363
V	331
VI	300
VII	121
VIII	37
High School	6
Total	1,334

The mean success in school life of girls at this age is indicated by the mean of these nine grades. Fifty per cent

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statement that the more successful children are taller and have larger chests than the less successful, but finds a uniform rate of growth in these dimensions.

My own results were reached before I knew of the work of the Russian scientists.

of the total number of girls is 667. Adding up the column, 464 is reached at Grade V; to add the girls in this grade would make the sum greater than 50 per cent of 1,334. The mean lies, therefore, in Grade V. The difference between 667 and 464 is 203, which is 61 per cent of 331. That is to say, a line drawn at the mean grade of girls, aged 13, would divide them into two groups, the one consisting of the High School, Grades VII, VI, and 61 per cent of the girls in Grade V, and the other, consisting of 39 per cent of Grade V, and Grades IV, III, II, and I. The total number would thereby be divided into two classes according to success in school life, and success in school life, like success in after life, is on the average a fair test of intelligence.

The actual division of the pupils into these two classes cannot be carried out until the number of observations at each pound in Grade V is multiplied by 0.61 and 0.39, thus making two columns, one of which contains 61 and the other 39 per cent of the observations in the grade. The former is added to the number of observations at each pound in Grades VI, VII, VIII, and the High School, and the latter similarly added to Grades IV, III, II, and I. The mean of the one group is the weight of the mean precocious girl and the mean of the other, the weight of the mean dull girl.

The weights calculated by this method for children of mean dullness and mean precocity are placed in Tables No. 15 and No. 16, in which the mean grade also appears.

TABLE NO. 15.

The Weight of the Boy of Mean Precocity and the Boy of Mean Dullness.

PRECOCITY.			DULLNESS.		
Age.	Grades.	Pounds.	Pounds.	Grades.	Age.
7	.70 I, II, III.....	48.64	46.69	Kn, .30 I	7
8	.29 I, II, III, IV.....	53.50	51.59	Kn., .71 I.....	8
9	.56 II, III, IV, V	58.64	56.12	I, .44 II	9
10	.96 III, IV, V, VI	64.05	60.95	I, II, .04 III.....	10
11	.25 III, IV, V, VI.....	69.57	66.96	I, II, .75 III.....	11
12	.45 IV,V, VI, VII, H. S..	75.24	72.26	I, II, III, .55 IV	12
13	.82 V, VI, VII, VIII.....	81.00	77.36	1, II, III, IV, .18 V.....	13
14	.88 VI, VII, VIII, H. S...	90.57	85.69	II, III, IV, V, 12 VI	14
15	.VII VIII, H. S....	105.27	94.78	II, III, IV, V, VI	15
16	.53 VIII, H. S.....	120.96	105.00	II,III,IV,V,VI,VII,.47 VIII.	16

TABLE NO. 16.

The Weight of the Girl of Mean Precocity and the Girl of Mean Dullness.

PRECOCITY.			DULLNESS.		
Age.	Grades.	Pounds.	Pounds.	Grades.	Age.
7	.76 I, II, III	46.96	44.68	Kn., .24 I	7
8	.27 I, II, III, IV	51.20	49.52	Kn., .73 I	8
9	.51 II, III, IV	56.25	54.32	I, .49 II	9
10	.88 III, IV, V, VI	61.34	59.44	I, II, .12 III	10
11	.22 III, IV, V, VI, VII,	66.73	64.84	I, II, .78 III	11
12	.48 IV, V, VI, VII, VIII	74.59	71.72	I, II, III, .52 IV	12
13	.61 V, VI, VII, VIII, H.S	86.43	80.39	I, II, III, IV, .39 V	13
14	.69 VI, VII, VIII, H.S	96.61	92.00	II, III, IV, 31 VI	14
15	.55 VII, VIII, H.S	104.54	100.03	II, III, IV, V, VI, .45 VII	15
16	.20 VIII, H. S	113.31	108.39	IV, V, VI, VII, .80 VIII	16

The meaning of these tables is shown graphically in Plate II. Here are seen three pairs of curves. The uppermost are the curves of increase in weight of boys and girls of mean precocity; the lowermost, the curves of increase in weight of boys and girls of mean dullness. The middle curves give the mean weights irrespective of grade. In each pair the curve of girls' weights is a broken line.

Tables No. 2 and No. 3 support the view that mean weight irrespective of grade, or, in other words, mean weight irrespective of success in school life, is also the mean weight of children of mediocre ability. If this view be correct, the curves of mean weight irrespective of grade may rightfully be compared with curves of weight of precocious and dull children, as has been done in Plate II. The fact that these curves of means irrespective of grade fall almost exactly between the curves of precocity and dullness justifies this comparison.

Again, the mean weight at each age, on the basis of intelligence, *i. e.*, the weight of the mediocre child, should be the same as the mean weight at each age irrespective of intelligence. The two preceding tables, No. 15 and No. 16, contain the mean weight of precocious and dull children. By adding these together at each age and dividing by 2, the weight of the mediocre child is secured. In Tables No. 17 and No. 18, these weights of mediocre children are compared with the

mean weights of the whole mass of observations at each age, irrespective of school grade.

TABLE NO. 17.

The Mean of the Weights of Boys of Mean Precocity and Dullness compared with the Mean Weight irrespective of School Grade.

Age.	Mean Precocity.	Mean Dullness.	Mean.	Mean irrespective of School Grades.
7	48.64 lbs.	46.69 lbs.	47.66 lbs.	47.73 lbs.
8	53.50	51.59	52.54	52.58
9	58.64	56.12	57.38	57.75
10	64.05	60.95	62.50	62.48
11	69.57	66.96	68.26	68.47
12	75.24	72.26	73.75	73.61
13	81.00	77.36	79.18	79.85
14	90.57	85.69	88.13	88.08
15	105.27	94.78	100.02	100.20
16	120.96	105.00	112.98	114.17

TABLE NO. 18.

The Mean of the Weights of Girls of Mean Precrocity and Dullness compared with the Mean Weight irrespective of School Grade.

Age.	Mean Precocity.	Mean Dullness.	Mean.	Mean irrespective of School Grades.
7	46.96 lbs.	44.68 lbs.	45.82 lbs.	45.84 lbs.
8	51.20	49.52	50.36	50.35
9	56.25	54.32	55.28	55.17
10	61.34	59.44	60.39	60.46
11	66.73	64.84	65.78	65.64
12	74.59	71.72	73.15	73.23
13	86.43	80.39	83.41	83.73
14	96.61	92.00	94.30	93.94
15	104.54	100.03	102.28	103.20
16	113.31	108.39	110.85	110.06

The coincidence in the two series is noticeable.

The three pairs of curves in Plate II may now be examined in detail. The three full lines of boys' weights run courses not strictly parallel. A slight divergence of the curves of the dull and the precocious is evident in the case of the older boys. This would seem to indicate that the difference in weight between dull and precocious boys increases as they grow older. It would further seem to show that this increasing divergence is associated chiefly with the acceleration of

growth at the beginning of puberty, and that precocious boys grow faster than dull boys.

These conclusions may perhaps have an element of truth, but the curves now under examination by no means prove their truth. For it must be noticed that the divergence in question is scarcely perceptible until ages 14 and 15 are reached, ages in which the number of observations is so small as to considerably increase the chance of error. No such divergence is seen in the case of girls' weights, in which the number of observations in the ages 14, 15, and 16 is very much larger.* Bearing this fact in mind, it may be affirmed that *the comparative rate of growth of dull, mediocre and precocious children of the same sex is the same at all ages from 7 to 16 inclusive.* The data at hand are not sufficient to decide whether this law is true of other ages in the period of growth.

Each boys' curve in Plate II is characterized by a gradual and very nearly uniform ascent until age 13 is reached. Here an acceleration begins, indicated by a more rapid rise of the curves, and this acceleration becomes still more rapid at age 14. It is the expression of the change which precedes puberty. A similar acceleration is seen in girls, but it takes place at an earlier age, the curves beginning their steeper rise at age 11. The curves in Plate II are plotted one directly above the other. The ordinates for the same age are made to coincide in all six curves. It can therefore be readily seen whether the period of acceleration begins earlier or later in dull than in precocious children. This seems not to be the case. *The acceleration in weight preceding puberty takes place at the same age in dull, mediocre and precocious children.*

The growth of boys and girls runs a parallel course in early childhood. At age 6, boys are heavier than girls, and this advantage is maintained for several years. But when the difference of sex begins to make itself felt, the relation between the weights of the sexes is changed, the boys lose their superiority and the curve of girls' weight rises above theirs.

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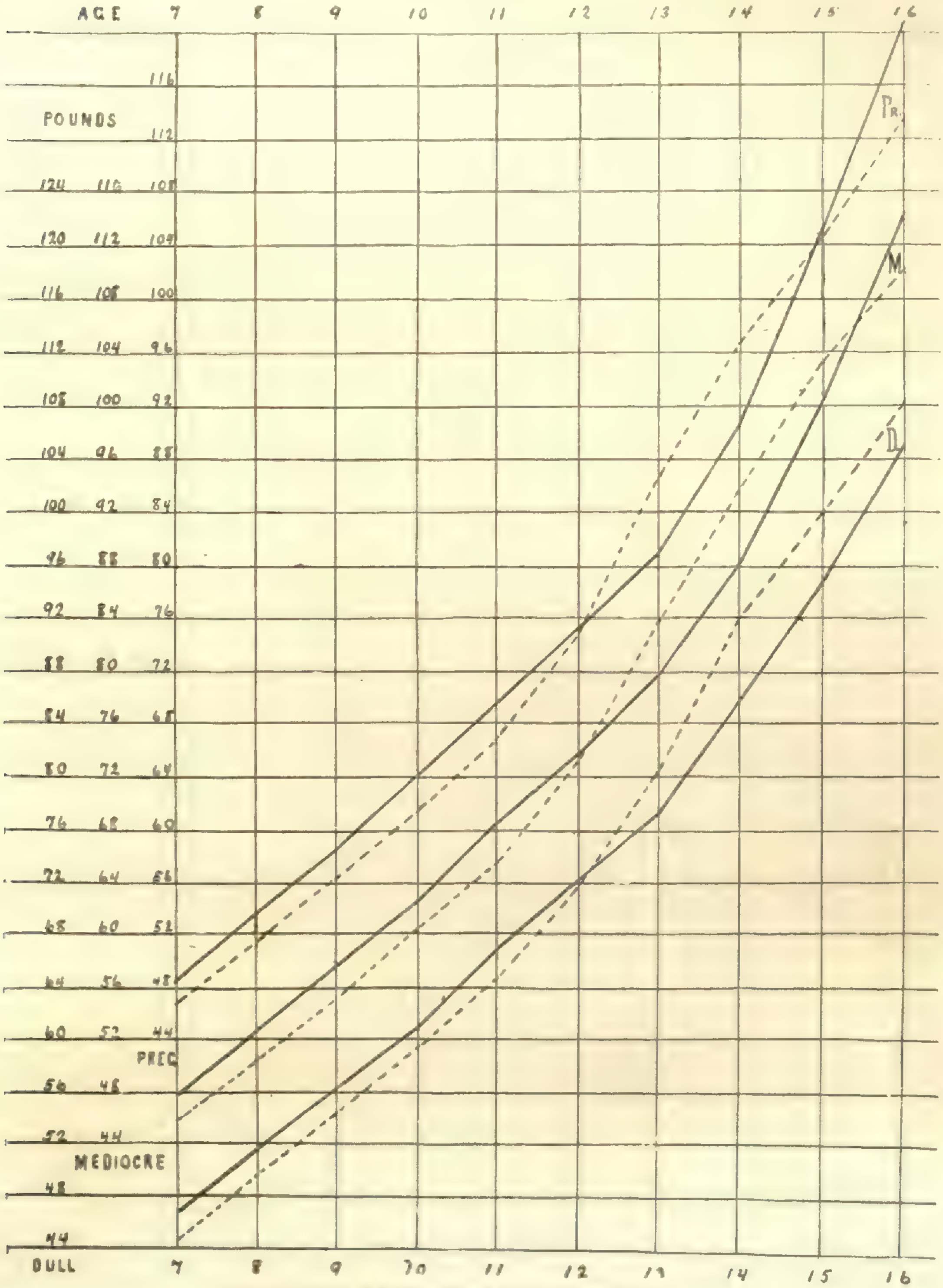
* The extent of this difference in number of observations is seen by comparing the columns on the left of Tables No. 2 and No. 3.

PLATE II.

THE RATE OF GROWTH IN WEIGHT OF DULL, MEDIOCRE AND PRECOCIOUS BOYS AND GIRLS.



FULL LINES REPRESENT BOYS' WEIGHT.
DASHED LINES REPRESENT GIRLS' WEIGHT.

This difference persists for about three years, and then the curves once more cross and the youth is once more heavier than the maid. In Plate II, the curves of girls' weights cross the boys' curves at the same age in dull, mediocre andprecocious children. *The point in the period of accelerated development at which girls become heavier than boys is the same in the dull, the mediocre and the precocious.*

The conclusions reached in this investigation are based on means and averages. How far they are applicable to individuals cannot be determined from the present data. For this, another method must be used. The same children must be weighed from year to year. The variation of the individual from the normal mean or average will then be known. But even without this information, a deduction of great practical importance can be made from the laws established by the present research. *No child whose weight is below the average of its age should be permitted to enter a school grade beyond the average of its age, except after such a physical examination as shall make it probable that the child's strength shall be equal to the strain.*

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VOL. VI. No. 8.

GEOMETRICAL CONSTRUCTIONS FOR CUTTING FROM A CONE OF REVOLUTION PLANE SECTIONS (*a*) OF GIVEN ECCENTRICITY, (*b*) OF GIVEN *LATUS RECTUM*.

EDMUND A. ENGLER.

Issued May 10, 1893.

GEOMETRICAL CONSTRUCTIONS FOR CUTTING FROM A CONE OF REVOLUTION PLANE SECTIONS (*a*) OF GIVEN ECCENTRICITY, (*b*) OF GIVEN *LATUS RECTUM*.*

EDMUND A. ENGLER.

(*a*) The formula generally used to express the eccentricity of a section of a cone of revolution is†

$$e = \frac{\cos\ (\theta+\alpha)}{\cos\ \alpha} \qquad (1)$$

in which

$e \equiv$ the eccentricity of the section.

$\alpha \equiv$ half the angle at the vertex of the cone.

$\theta \equiv$ the angle which the plane of the section makes with that element of the cone which it intersects nearest the vertex of the cone.

and therefore

$\theta+\alpha \equiv$ the angle which the plane of the section makes with the axis of the cone.

*Presented by title to The Academy of Science of St. Louis, May 16, 1892; read before the New York Mathematical Society, May 6, 1893.

†See Todhunter's "Conic Sections," 7th Ed., p. 310. London: Macmillan & Co., 1881.

Discussion of this equation shows that e may vary

$$\text{from } 0, \text{ when } \theta+\alpha = \frac{\pi}{2}$$

$$\text{to } \frac{1}{\cos\ \alpha}, \text{ when } \theta+\alpha = 0$$

A conic section of any desired eccentricity (between the limits) can therefore be cut from any cone of revolution by giving to the angle $\theta+\alpha$ a suitable value.

The following geometrical construction gives the value of $\theta+\alpha$ for any assumed eccentricity. The construction is the same for elliptic, hyperbolic and parabolic sections; but to avoid confusion in the figure they are here considered separately.

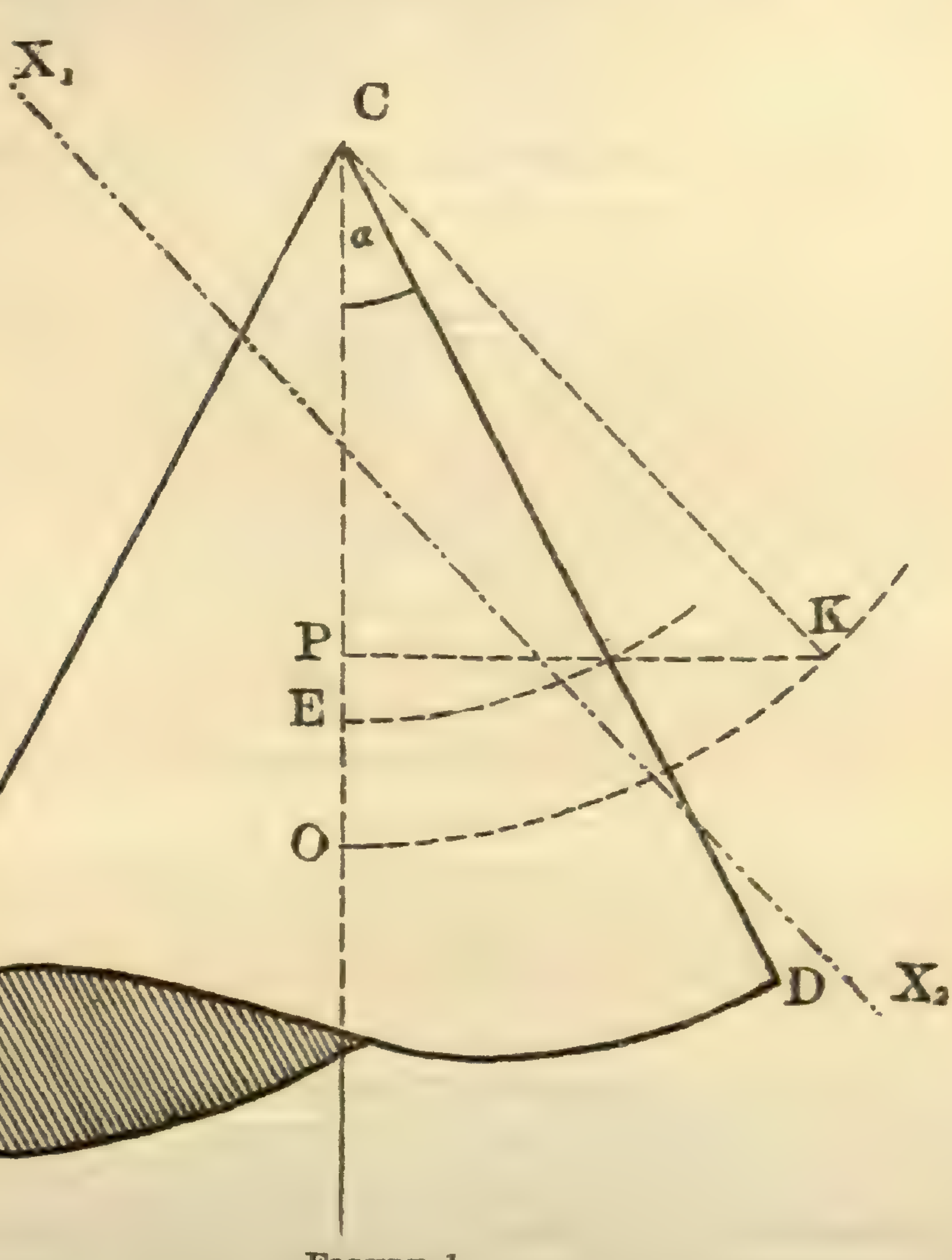

FIGURE 1.

For the *elliptic section* $[e < 1]$, Figure 1, with C as a center

and any radius, CO, ($\equiv 1$), describe an arc. With C as a center and a radius CE, equal to the given eccentricity (less than unity) describe another arc. A perpendicular to the axis of the cone through the point where the second arc meets the element of the cone intersects the first arc at a point K, outside the cone.

Then, from the figure,

$$CP = CE \cos \alpha = e \cos \alpha$$

Also

$$CP = CO \cos ECK = \cos ECK$$

$$= \cos (\alpha + DCK)$$

Whence

$$\cos (\alpha + DCK) = e \cos \alpha$$

$$DCK = \theta$$

$$ECK = \theta + \alpha$$

Therefore any plane making with the axis of the cone the same angle as does CK, such for example as $X_1 X_2$ (drawn parallel to CK) will cut from the cone an *ellipse* of the given eccentricity.

For the *hyperbolic section* $\left[e > 1 \text{ but } < \frac{1}{\cos \alpha}\right]$, Figure 2, with C as a center and any radius, CO, ($\equiv 1$), describe an arc. With C as a center and a radius, CE, equal to the given eccentricity $\left(\text{greater than unity, but less than } CD = \frac{1}{\cos \alpha}\right)$, describe another arc. A perpendicular to the axis of the

cone through the point where the second arc meets the ele-

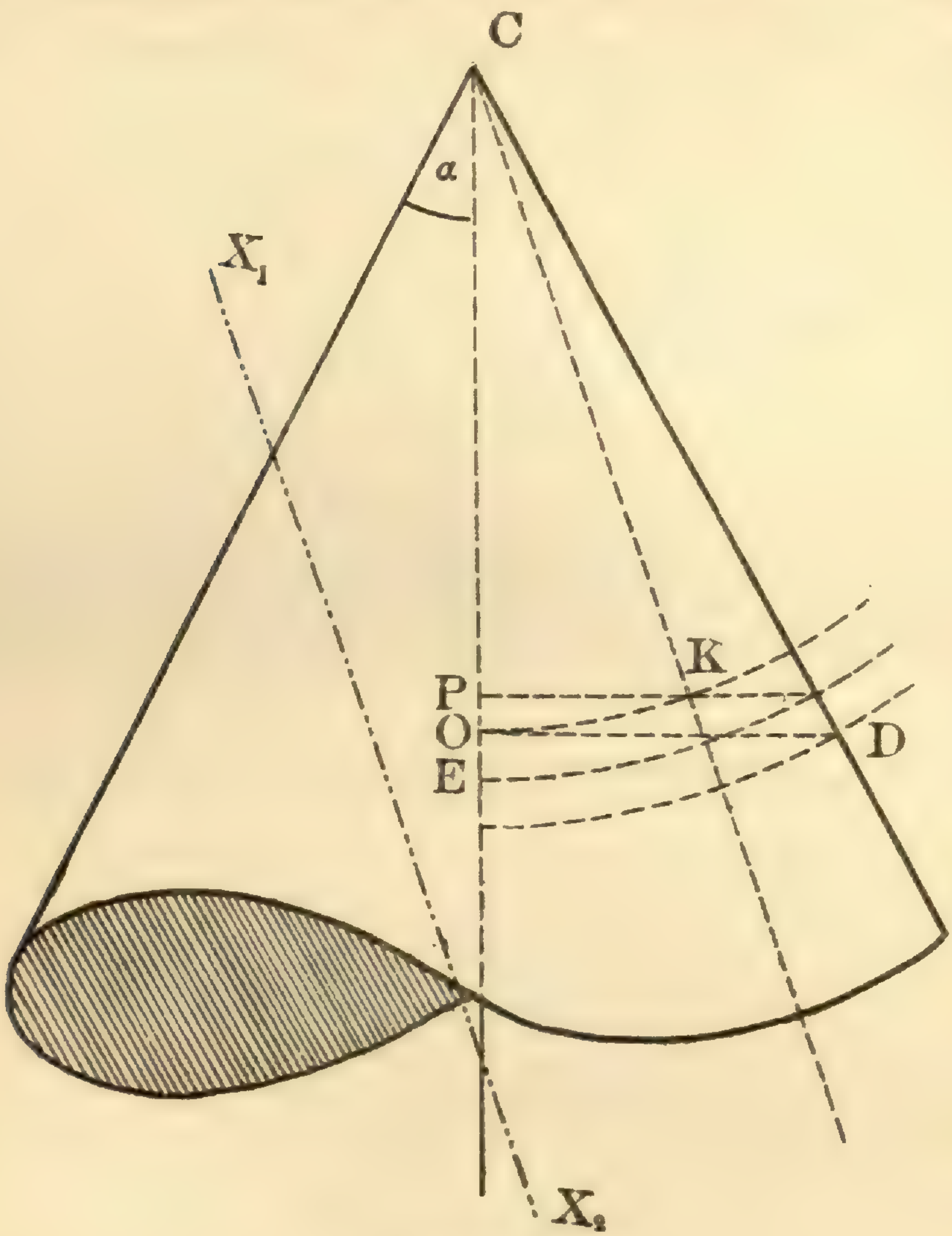

FIGURE 2.

ment of the cone intersects the first arc at a point K, inside the cone.

Then, from the figure,

$$CP = CE \cos \alpha = e \cos \alpha$$

Also

$$CP = CO \cos ECK = \cos ECK$$

$$= \cos (\alpha - DCK)$$

Whence

$$\cos (\alpha - DCK) = e \cos \alpha$$

$$DCK = -\theta$$

$$ECK = \theta + \alpha$$

Therefore any plane making with the axis of the cone the same angle as does CK, such for example as $X_1 X_2$ (drawn parallel to CK) will cut from the cone a *hyperbola* of the given eccentricity.

It is to be noticed that if CE, the radius of the second arc, is taken greater than $CD = \frac{1}{\cos \alpha}$, the limit of the eccentricity, the perpendicular to the axis of the cone drawn as above will not intersect the first arc; the construction is therefore impossible, and no section of the cone with such eccentricity exists.

Also, the section of maximum eccentricity is shown by the construction to be the section cut from the cone by a plane parallel to the axis.

For the *parabolic section*, $e = 1$, $\theta = 0$, and CK coincides with CD, an element of the cone.

Therefore, any plane making with the axis the same angle as do the elements of the cone will cut from the cone a *parabola*.

(*b*) The formula generally used to express the *latus rectum* of a conic is

$$2p = \frac{2b^2}{a} \qquad (2)$$

in which

$2p \equiv$ the *latus rectum*.
$2a \equiv$ the transverse axis.
$2b \equiv$ the conjugate axis.

The equation of a conic referred to its vertex and in terms of its semi-axes is

$$y^2 = \frac{b^2}{a^2}(2ax \mp x^2) \qquad (3)$$

The equation of a section of a cone of revolution, referred to its vertex and in terms of the angle at the vertex of the cone and the constants which define the position of the plane of the section, may be written

$$y^2 = \pm \frac{\sin\ \theta\ \sin\ (\theta+2\alpha)}{\cos^2\alpha} \left\{ \pm \frac{2\ c\ \sin\ \alpha\ \cos\ \alpha}{\sin\ (\theta+2\alpha)}\, x \mp x^2 \right\} \quad (4)$$

in which the same notation for angles is used as in (1) and

$c \equiv$ the distance from the vertex of the cone to the nearest point of the section.

In both these equations, (3) and (4), the upper signs are to be taken for the case of the elliptic section, and the lower signs for the case of the hyperbolic section.

From the symmetry of equations (3) and (4)

$$2a = \pm \frac{2\ c \sin\ \alpha \cos\ \alpha}{\sin\ (\theta + 2\,\alpha)} \quad (5)$$

and

$$\frac{b^2}{a^2} = \pm \frac{\sin\ \theta\ \sin\ (\theta\ +2\ \alpha)}{\cos^2\ \alpha} \quad (6)$$

Multiplying (5) by (6)

$$\frac{2b^2}{a} = 2\ c \sin\ \theta \tan\ \alpha$$

or, by (2),

$$2p = \frac{2b^2}{a} = 2\ c \sin\ \theta \tan\ \alpha. \quad (7)$$

The perpendicular from the vertex of the cone to the plane of the section ($\equiv k$) is evidently $c \sin\ \theta$; whence from (7)

$$k = \frac{p}{\tan\ \alpha} \quad (8)$$

Any plane, therefore, at a distance $\frac{p}{\tan \alpha}$ from the vertex of the cone will cut from the cone a section whose *latus rectum* is $2p$.

The following geometrical construction gives the value of k for any assumed value of p.

Parallel to an element, CP, of the cone, (Figure 3), in

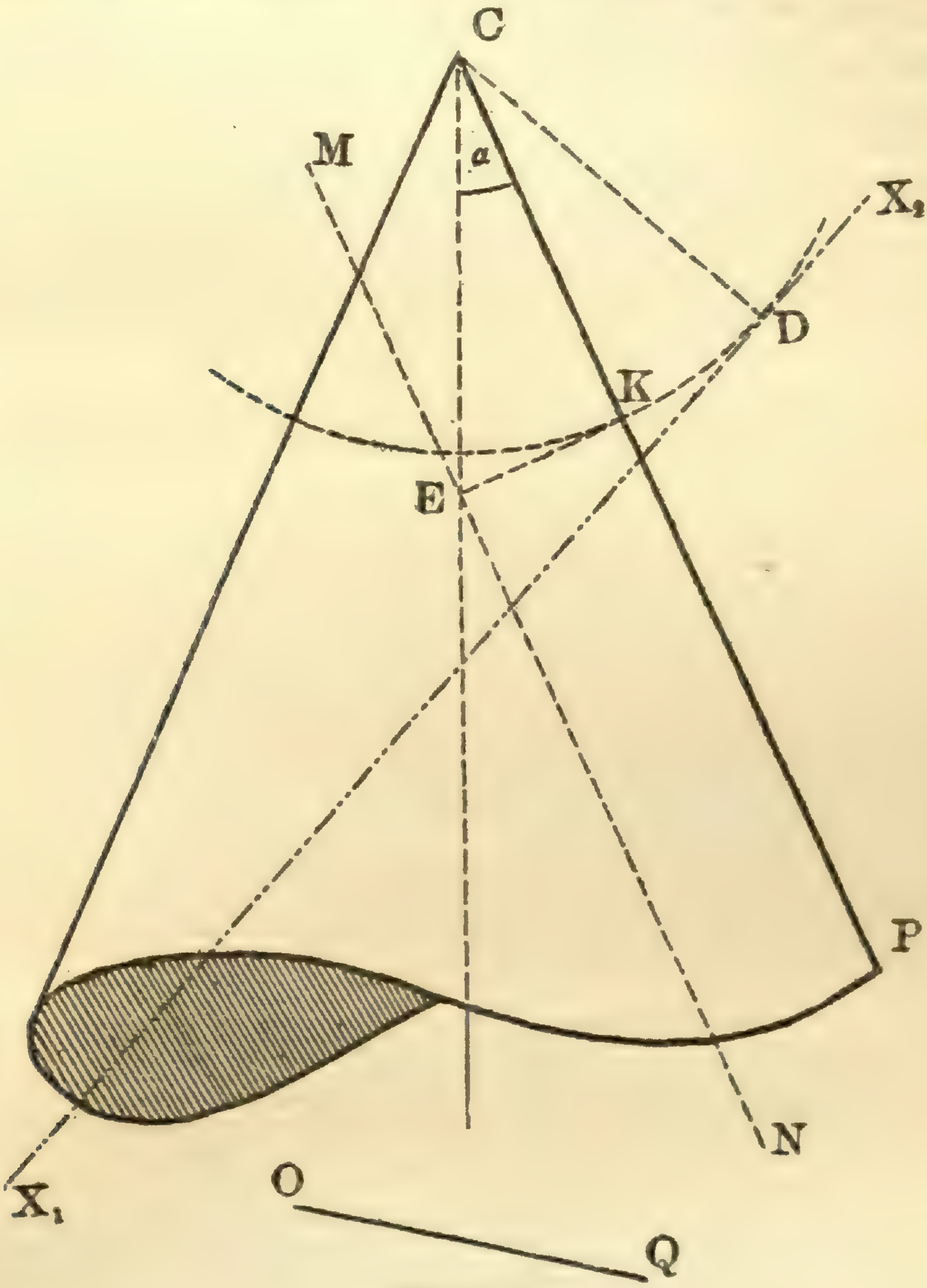

FIGURE 3.

the axial plane through this element, and at a distance from it equal to one-half the given *latus rectum*, OQ, draw a line MN. Through E, the intersection of MN with the axis,

draw EK perpendicular to CP, and intersecting CP at K. With C as a center and CK as a radius describe a sphere.

Then from the figure

$$CD = k = CK = \frac{EK}{\tan\ \alpha} = \frac{p}{\tan\ \alpha}$$

Therefore any plane tangent to this sphere, such for example as $X_1\ X_2$, will cut from the cone a section of the given *latus rectum*.

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VOL. VI. No. 9.

SCLEROTINIA LIBERTIANA, FUCKEL, WITH A BIBLIOGRAPHY OF FUNGUS ROOT DISEASES.

L. H. PAMMEL.

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SCLEROTINIA LIBERTIANA, FUCKEL, WITH A BIBLIOGRAPHY OF FUNGUS ROOT DISEASES.

By L. H. Pammel.

During the months of July and August, 1890, I became interested in a disease which caused the common sunflower, *Helianthus annuus*, to wilt and die suddenly. In a note made at the Indianapolis meeting of the Society for the Promotion of Agricultural Science[1] attention was called to this disease.

I designated the disease as Root-rot of Sunflower.[2] The external manifestations are similar to other root-rot diseases, especially those caused by *Ozonium auricomum*, Pammel,[3] and *Leptosphaeria circinans*.[4]

A healthy looking plant suddenly wilts. Previous to this the plant appeared nearly normal except a little browning of the stem close to the ground. Closer examination of the stout tap root revealed a white mycelium over the surface, in the pith, and in the interior of the root and stem close to the ground. In some places this mycelium had collected in white masses. A root placed in a moist chamber caused the mycelium to grow vigorously, and a yellow fluid oozed out from the surface. These masses slowly changed in color, becoming black. The hard solid sclerotia varied greatly in size and shape. The majority were about the size of a pea, round, elliptical, or elongated. In some cases the sclerotia filled the cavity occupied by the pith, and in that case they were flat-

[1] Proceedings Soc. Promotion of Agricultural Science, 1890, p. 91.

[2] Saint-Gal mentions (Revue Mycologique, 1879, p. 122) *Sclerotium compactum* DC. on this species as well as *H. tuberosus*.

[3] Bulletin Nos. 4 and 7, Texas Agricultural Experiment Station; Atkinson, Method of obtaining pure cultures of Pammel's fungus root-rot of cotton, Bot. Gazette, Vol. XVIII, p. 16.

[4] J. Kühn, Krankheiten der Kulturgewächse, Berlin, 1858, p. 245; Sorauer, Pflanzenkrankheiten, Vol. II, p. 355.

tened on two sides. Sclerotia, as DeBary [1] has pointed out, show marked differences in their anatomical characters.

The sclerotia of several species of *Sclerotinia* have a thin, black, smooth or rough rind; the medulla is white or whitish. The rind of the sclerotia to which *Agaricus tuberosus* belongs is yellow-brown and quite smooth. The sclerotium of *Claviceps* is well represented by common ergot. It consists of a white medulla surrounded by a violet brown rind.

It may be of interest to briefly review some of the different forms of the species of *Sclerotinia*. One of the best known is the *Sclerotinia libertiana*, Fkl., commonly called *Peziza sclerotioides*, Lib.[2] This fungus has been the subject of several interesting papers. Kühn [3] was familiar with this fungus, although he gave only a short description. DeBary,[4] gained a more accurate knowledge of the fungus. He made a most interesting communication on the conditions necessary for the penetration of the germ tubes into the tissues in order that it could lead a parasitic life.

Brefeld's work confirms the results of DeBary's investigation. His studies of *Sclerotinia tuberosa* [5] are noteworthy as showing that the fungus can be grown in nutrient media. Just as this paper was about to be sent away there has come to me Humphrey's [6] paper on a Sclerotium Disease of Cucumbers, in which the author gives a most interesting account of the life history of *Sclerotium libertiana*. The author made suc-

[1] Comparative Morphology of Fungi, Mycetozoa, and Bacteria. English translation, Garnsey and Balfour. Oxford. 1887. pp. 30–43.

[2] Symbolae mycologicae, Beiträge zur Kentniss der Rheinischen Pilze, Peziza sclerotium, Libert. Exs. No. 326. Brefeld, Botanische Untersuchungen über Schimmelpilze, Untersuchungen aus dem Gesammtgebiete der Mykologie, Heft IV. Leipzig. 1881. p. 112. P. sclerotii, Fuckel, Bot. Zeit. 1861. No. 35. The synonymy is given in Saccardo, Sylloge Fungorum, Vol. VIII, p. 196, and by Rehm in Rabenhorst's Kryptogamen-Flora, Vol. I, Abth. III, pp. 800–817.

[3] Krankheiten der Culturgewächse, p. 128.

[4] Morphologie and Physiologie der Pilze, p. 35, 60, 201. Botanische Zeitung, 1886, Nos. 22–27.

[5] Fuckel, Symb., p. 331. Sylloge Fungorum, Vol. VIII, p. 195. Brefeld, l. c., p. 112 (*Peziza tuberosa*).

[6] A Sclerotium Disease — Sclerotinia libertiana, Fkl. Tenth Annual Report of the Board of Control of the Mass. State Agricultural Experiment Station, 1892, p. 212.

cessful cultures of the fungus on prune gelatin, and sterilized bread saturated with an infusion of prunes. He has confirmed DeBary's work in regard to the mode of infection of the plant. Humphrey shows that when a cucumber plant is injured, and spores placed in the cut, infection does not occur, but if they are sown in nutrient media on a healthy and uninjured plant infection is easy, and the fungus quickly spreads through the tissues.

Humphrey has also shown that a species of *Botrytis* is connected with this Sclerotinia. This fact has been known for some time of *Sclerotinia fuckeliana*, DeBary.

Behrens[1] has recently studied a very destructive disease of hemp, but leaves some doubt as to whether the fungus studied by him is identical with *Sclerotinia libertiana*, Fkl. or *Sclerotinia fuckeliana*, DeBy. "Es muss also fortgesetzten Untersuchungen überlassen werden, zu entscheiden, ob der hier vorliegende Hanfkrebs durch *Sclerotinia libertiana*, Fkl. order durch *Scl. fuckeliana*, DeBy. verursacht ist." He found present on the hemp *Botrytis cinerea*, and some inoculations made with spores nourished in sugar solution produced the mycelium of *Sclerotinia*. Humphrey's work leaves no doubt as to the genetic connection, since he used modern culture methods. His work is therefore of special interest.

Tichomirow, who found a similar disease of hemp in Russia, thought it should be referred to *Peziza kauffmanniana*, but in all probability his fungus is nothing more than *Sclerotinia libertiana*, as DeBary has shown that this fungus will produce a disease of hemp. Rehm,[2] in his revision of the genus *Sclerotinia*, in Rabenhorst's Kryptogamen-Flora, makes *Peziza kauffmanniana* a synonym of *Sclerotinia libertiana*, Fkl. Lastly Sorauer[3] refers to *Botrytis infestans*, Hazsl., as occurring on hemp, and Behrens thinks this is identical with *B. cinerea*.

[1] Ueber das Auftreten des Hanf Krebses im Elsass. Zeitschrift für Pflanzenkrankheiten, Vol. I, p 208.

See also Tichomirow, Peziza Kauffmanniana, eine neue Sclerotium stammende und auf Hanf schmarotzende Becherpilz-species. Bull soc. naturalistes de Moscou. 1868.

[2] L. c., pp. 800–824. See p. 816.

[3] Die Schäden der einheimischen Kulturpflanzen, Berlin, 1888, p. 229.

Several other interesting forms of the sclerotinia have been studied. Wakker [1] made a study of a destructive disease of hyacinth and scilla bulbs.

The period of time that elapses before germination of sclerotia begins seems to vary somewhat. Brefeld found that some germinated immediately while others did not do so till the following spring, while some which had been dry for several years soon germinated when moistened. Humphrey observed that cucumber sclerotia began to develop one month after they were placed in a moist chamber on sand.

The specimens from sunflowers were placed in a wide mouthed bottle, the lower inch and a quarter containing coarse sand. The sand was then moistened with distilled water and a dozen or more sclerotia were placed on the sand in September, 1890. A tight fitting cork prevented evaporation. The bottle was then allowed to stand in the laboratory. In the spring of 1891 brownish strands developed, but there was no indication of fruiting bodies nor did any develop that summer; but about the middle of March, 1892, yellowish brown bodies made their appearance. In several cases a single sclerotium bore twenty-four tapering stalks, whose tips were somewhat darker than the base. These bodies were rough by the outgrowth of tufts of hyphae. The cork was then placed on the bottle loosely. As some water was lost by evaporation, the stalked bodies began to droop. Water was added, which caused them to straighten out and assume their normal condition. The bottle was left standing at one side of the room, which caused the stalked affairs to bend to the light. The whole bottle was then covered up except a small hole through which the light penetrated. The stalked bodies again exhibited a tendency to bend to the light.

This is well described by Humphrey as follows: "These stalks, in their aerial portion, are very sensitive to light. In cultures before a window, the young stalks grew from the first strongly toward the window. When the culture chamber was turned through 180 degrees to make them point away from the window, they very promptly responded to the stimulus of the

[1] Contributions a la pathologie végétale. Archives néerlandaises, XXXIII, pp. 373–400; Journal Mycology, Vol. V, p. 224.

light, and in a single day showed strong heliotropic curvature. In two or at most three days they had bent sharply upon themselves, and were again directing their tips obliquely towards the light in response to the combined influence of negative geotropism and positive heliotropism.''

The tip began to increase in size, in eight days the stalks began to enlarge very decidedly at the tip; during the early stage it consisted of a slender thread with a small depression at the upper end. As the depression became larger the end was more or less flattened and after it had attained full size the whole fell and rapidly disappeared. A cross section through one of the cups shows a very large number of asci, each of which contains eight ascospores. Between the asci are innumerable fine threads, the septate paraphyses. The ascospores germinate in a short time. The exact time was not noted, but Wakker [1] observed that germination in *Sclerotinia tuberosa* occurred in 24 hours.

The germ tube bears sporidia which are entirely functionless.

Wakker in studying the different Sclerotinias finds that in the hyacinth disease the sclerotinia cup rarely develops, which leads him to believe that *Sclerotinia tuberosa* is the truly indigenous species of Europe and that *Sclerotinia libertiana* and *S. bulborum* are derivatives, but under certain conditions have become somewhat changed.

EXPLANATION OF PLATES.

Plate I.

1. Sunflower root showing sclerotia forming.
2. *Sclerotinia libertiana*, Fuckl. Stalk showing hyphae springing from the main stalk in the form of fine threads — magnified about fifteen times.
3. Cells of the stalk more magnified.
4. Hyphae from sunflower root before the formation of sclerotia, magnified 500.

Plate II.

5. Hyphae from the same source but branched, magnified 500.
6. Sclerotium with fruiting body, twice enlarged.
7. Sclerotium with fruiting body, earlier stage × 2.
8. Asci and ascospores, magnified 350.
9. Cross section of sclerotium: rind shown at *a*; at *b*, interior white portion, magnified 500.

[1] l. c.

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Some years since when I was studying Texas root-rot of cotton it became necessary for me to look up the bibliography of root-rot diseases. I had catalogued at that time something over 370 papers. Much literature has been added since and I thought it well to add some of these papers. These begin with No. 372. I have not seen all of the original papers, but many have been examined, and in this connection I desire to express my obligations to Prof. Wm. Trelease, who kindly allowed me to look through his valuable pamphlets on fungi. In the matter of proof-reading I have been assisted very materially by J. Christian Bay, who has also aided me with titles of papers. Current periodicals, especially Botanische Zeitung, Hedwigia, Grevillea, Annales des Sciences Naturelles, Centralblatt für Bakteriologie und Parasitenkunde, Botanisches Centralblatt, Zeitschrift für Pflanzenkrankheiten, Revue Mycologique, Journal of Mycology, Botanical Gazette, Bulletin Torrey Botanical Club, Just Botanischer Jahresbericht, a partial set of Pringsheim Jahrbücher, Agricultural Science, and other journals, have been examined. I have in some cases availed myself of the excellent references in Botanisches Centralblatt, Just Botanischer Jahresbericht and D. G. Fairchild's Index to recent literature in Journal of Mycology. Where a good abstract occurred I have usually made a reference to the abstract in connection with the original. It is a question as to how far one should extend the bibliography of any subject, especially where many popular articles are written. In numerous instances these articles do not contain scientific information and are practically useless, but it is hard to find a dividing line. In this bibliography I have included all popular articles bearing on the subject, which I have seen.

In this bibliography I have attempted only to give titles of papers that bear on the question of fungi that attack roots and underground stems. I have included some however that affect stems just above the ground. The papers on *Phytopthora infestans* have not been included, as this would almost make a bibliography as large as the present one. It is now well known that rotting of potatoes may be due to bacteria, and whenever it was clear that the author referred to such diseases the papers were included.

I hope at some future time to publish a list of the fungi as well as the hosts upon which they occur.

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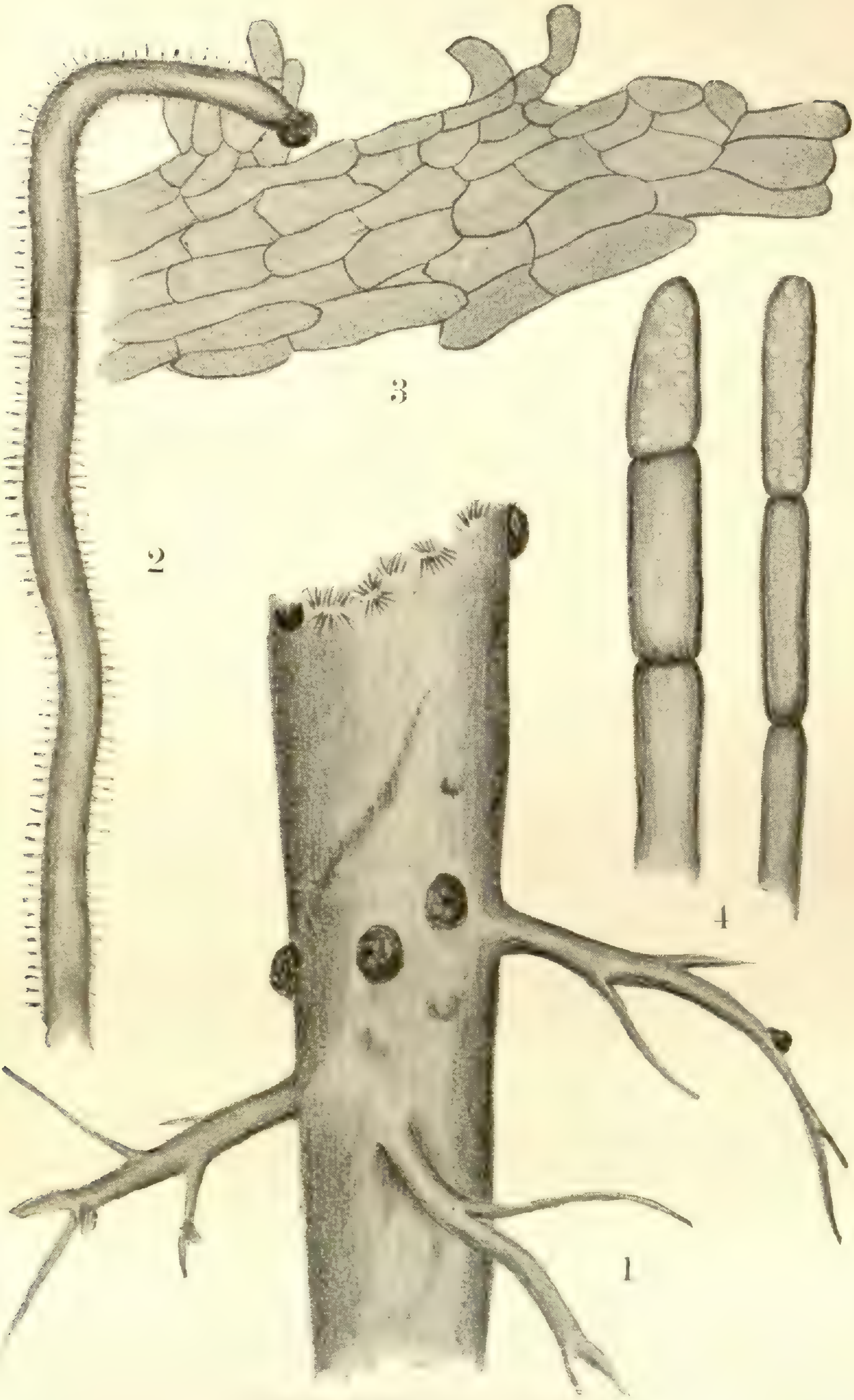

PAMMEL, SCLEROTINIA — PLATE I.

PAMMEL, SCLEROTINIA — PLATE II.

Transactions of The Academy of Science of St. Louis.

VOL. VI. No. 10.

THE RELATION BETWEEN THE GROWTH OF CHILDREN AND THEIR DEVIATION FROM THE PHYSICAL TYPE OF THEIR SEX AND AGE.

WM. TOWNSEND PORTER.

Issued November 14, 1893.

THE RELATION BETWEEN THE GROWTH OF CHILDREN AND THEIR DEVIATION FROM THE PHYSICAL TYPE OF THEIR SEX AND AGE.

WM. TOWNSEND PORTER.

Quetelet induced from his measurements of children the law that the weights, heights or other physical dimensions at each age in the period of growth are approximations of a median value,[1] about which they are grouped in the form of a probability curve, being related to the median value as the individual observations in a series of measurements of the same thing are related to its actual size. Quetelet assumed that the median value of an anthropometric series expressed the physiological type of the series and that each deviation from this value expressed the physiological difference between an individual and the type. Fifty years of research have placed the truth of Quetelet's law beyond all doubt and have not weakened the reasonableness of his assumption, so that both law and hypothesis are rarely questioned and are regarded as a secure base from which to explore the phenomena of growth.

The degree of deviation of the individual measurements from the median value of an anthropometric series is measured by the Probable Deviation, that value which, in the words of Lexis,[2] is as often exceeded as attained. Hence, if Quetelet's theory is true, the Probable Deviation is a measure of the degree of deviation of individuals from their Physical Type. The Probable Deviation from the median value of a

[1] *Moyenne* of Quetelet, see *Lettres sur la Théorie des Probabilités*, Bruxelles, 1846, page 66; and *mean* of Sir John Herschel and other English writers, see *Edinburg Review*, 1850, page 23.

[2] Ueber die Theorie der Stabilität statistischer Reihen. Hildebrand's Jahrbücher für Nationalökonomie und Statistik. Bd. 32, 1879, S. 60–98.

See page 62.

series containing many measurements may be calculated by the approximation formula

$$d = \pm 0.8453 \frac{\Sigma\delta}{n} \qquad (1)$$

where d = Probable Deviation,

δ = Deviation of individual from median value,

$\Sigma\delta$ = Sum of individual deviations,

n = Total number of observations.

The Probable Deviation contains the Error of Observation, as well as the Physiological Difference of the Individual from the Type. The Error of Observation, in a large series of measurements, is always relatively small. Its insignificance can be made clear in several ways. If the height of one boy at any age is measured 1000 times, the Probable Deviation will be much smaller than when the heights of 1000 boys at that age are measured once. Compare, for example, the Probable Deviation from the average height of one boy aged 17 measured 78 times with that of 78 boys aged 17 measured once, the measurements being made under conditions as nearly alike as possible in both instances.

	One Boy aged 17 Measured 78 times.	78 Boys aged 17 Measured once.
Average Height	176.28 cm.	165.13 cm.
Probable Deviation	± 0.24 cm.	± 5.15 "

In the single boy, the Difference of the Individual from the Type is not present and the Probable Deviation is very small: in the 78 boys, the opposite is true. Yet the difficulty of correct measurement and hence the Error of Observation in each measurement in the two series cannot differ greatly. It follows that by far the greater portion of Probable Deviation is made up of the Physiological Difference of Individual from Type.

Again, the Error of Observation is inversely as the square root of the number of observations and should, were it an important constituent of the Probable Deviation, cause the latter to increase as the number of observations decreased.

Thus, in the following table, comparing the Relative Probable Deviation from the average height standing of boys with the square roots of the number of observations, the Probable Deviation should be much greater at ages 17 and 18, in which the number of observations is small, than at age 10 or 11, in in which the observations are much more numerous. A look at the figures shows that the Probable Deviation is very little

Age at nearest Birthday.	Number of Observations.	Square Root.	Relation of Probable Deviation to Average.
6	709	26.63	3.1 %
7	1850	43.01	3.2
8	2223	47.15	3.3
9	2205	46.95	3.0
10	2087	45.68	3.1
11	1819	42.63	3.2
12	1653	40.67	3.2
13	1268	35.62	3.5
14	925	30.42	3.8
15	490	22.14	4.1
16	189	13.75	3.7
17	78	8.85	3.1
18	29	5.40	2.8

influenced by variations in the number of observations, within the limits given here. The Probable Deviation may, therefore, without any error of importance, be considered as the Physiological Difference between the Individual and the Type.

Not all observers have taken the Median Value as the Type. The arithmetic mean is frequently employed in Germany, Denmark and elsewhere. In a large series the difference between the two is so small that either may be safely used. The maximum and the mean Median minus Average values for the physical dimensions studied in this paper are as follows:—

MEDIAN MINUS AVERAGE VALUE.

Dimension.	Unit of Measurement.	Maximum.		Arithmetic Mean.	
		Boys.	Girls.	Boys.	Girls.
Weight.....	Kilogram.....	0.73	0.74	0.23	0.25
Height Standing...	Centimetre	1.00	1.10	0.50	0.49
Height Sitting.....	Centimetre	0.94	0.99	0.44	0.67
Span of Arms.....	Centimetre	1.35	1.33	0.53	0.59
Girth of Chest.....	Centimetre	0.84	0.71	0.44	0.46

There can, therefore, be no objection to the use of the

Average in place of Median Value in the series about to be studied.

The accuracy of the average can be estimated by the formula:[1]

$$E = \pm \frac{d}{\sqrt{n}} \qquad (2)$$

where E = Probable Error of Average,
d = Probable Deviation from Average,
n = Number of Observations.

The values for E are given in Tables No. 6, 7 and 8.

It has already been said that the Physiological Difference between the Individual and the Type is expressed by the Probable Deviation from the Average. According to Geissler and Uhlitzsch,[2] the interval between Average minus d and Average plus d increases with the age. The values of d found by them in their measurements of height standing are as follows (page 33):

AGE.	PROBABLE DEVIATION ($A \pm d$). *Boys.* ±	*Girls.* ±
6½ to 7 years	3.4488	3.5926
7 " 8 "	3.5841	3.7362
8 " 9 "	3.8546	3.8293
9 " 10 "	4.0067	3.7785
10 " 11 "	4.2181	4.2265
11 " 12 "	4.2434	4.4125
12 " 13 "	4.5984	4.8013
13 " 14 "	4.7844	5.2155
Over 14 "	5.1479	4.8530

The authors say concerning this table (page 34): —

" Hieraus geht hervor, dass diese Intervalle mit dem Alter " im Allgemeinen zunehmen und es dürfte dies auch ganz " natürlich erscheinen, da wohl anzunehmen ist, dass die das " Wachsthum hemmenden bez. fördernden Ursachen bei den " meisten Individuen ziemlich dieselben bleiben, den Unter-

[1] Formulas (1) and (2) are contained in L. Stieda's paper: Ueber die Anwendung der Wahrscheinlichkeitsrechnung in der anthropologischen Statistik. *Archiv für Anthropologie*, Bd. xiv, 1882, S. 167–182.

[2] Arthur Geissler and Richard Uhlitzsch. Die Grössenverhältnisse der Schulkinder im Schulinspectionsbezirk Freiberg. *Zeitschrift des königlichen Sächsischen Statistichen Bureaus*, xxxiv, Heft 1 and 2, 1888, S. 28–40.

" schied also in der Grösse der Individuen immer merklicher
" hervortreten lassen. Auch hinsichtlich der Geschlechter ist
" ein Unterschied deutlich bemerkbar und zwar zeigen sich
" für die Mädchen vom 11 Jahre an grössere Schwankungen
" als für die Knaben. Da aber beobachtet worden ist, dass
" die Mädchen circa zwei Jahre vor Eintritt der Pubertäts-
" periode verhältnissmässig rascher wachsen, so dürfte die
" Verschiedenheit, mit welcher der Eintritt dieser Zeit erfolgt,
" wohl ein Grund mit sein für die grösseren Schwankungen."

It appears from this extract from the valuable work of Geissler and Uhlitzsch that they were very near discovering the law which it is the purpose of this paper to demonstrate and would certainly have done so had they not contented themselves with the Absolute Probable Deviation, in which the real Physiological Difference of Individual from Type lies hidden, and had the material furnished them been sufficiently extensive. The Absolute Probable Deviation is entangled with the size of the individual, and its true value can be known only when this disturbing factor is removed. It is the relation between Probable Deviation and size of individual that must be studied, if the character of the Probable Deviation would be known. But even if Geissler and Uhlitzsch had pursued the method just suggested, the limitations of their material would have prevented them from solving the problem completely. For the material given them to analyze extended no further than the fourteenth year, with some observations over, almost wholly missing the period of pre-pubertal acceleration in boys and the early pubertal years in girls and entirely omitting the early pubertal years in boys.

It would seem from their results that the Probable Deviation increases with the age, whereas it shall be presently shown that the Absolute Probable Deviation in height standing as well as in weight, height sitting, span of arms and girth of chest does not increase with age during the whole period of growth. Moreover, the Relative Probable Deviation does not increase during seven of the nine years of boys' growth and five of the nine of girls' growth included in the observations of Geissler and Uhlitzsch, and shows a merely secondary relation

to age during the remaining years. They state further that the amount of the Probable Deviation from age 11 on is greater in girls than in boys, meaning of course that this is true within the limits of their own observations. A wider experience shows that the Absolute Probable Deviation in height standing of girls ceases to be greater than that of boys at age 14 (nearest birthday). Finally, it does not appear from the context that the statement "Da aber beobachtet worden ist, "dass die Mädchen circa zwei Jahren vor Eintritt der Puber- "tätsperiode verhältnissmässig rascher wachsen, so dürfte die "Verschiedenheit, mit welcher der Eintritt dieser Zeit erfolgt, "wohl ein Grund mit sein für die grösseren Schwankungen" includes the conception of the relation of the Probable Deviation to the quickness of growth (to be demonstrated below), as distinct from the absolute difference in size of boys and girls at this period.

Before applying to the present material the ideas which the foregoing paragraphs have attempted to state with some precision, it will be interesting to compare the Probable Deviation of Height Standing of German children in the Freiberg district with that of the St. Louis children.

TABLE No. 1.

A Comparison of the Absolute Probable Deviation from the Average Height Standing of School Children in the Freiberg School District (Geissler & Uhlitzsch) and in the St. Louis Public Schools.

St. Louis Age at Nearest Birthday.	Boys.		Girls.		Freiberg Age.
	St. Louis.	Freiberg.	St. Louis.	Freiberg.	
	±	±	±	±	
6	3.40 cm.	3.4488 cm.	3.42 cm.	3.5926 cm.	6½ to 7 yrs.
7	3.61 "	3.5841 "	3.75 "	3.7362 "	7 – 8 "
8	3.89 "	3.8546 "	3.70 "	3.8293 "	8 – 9 "
9	3.75 "	4.0067 "	3.83 "	3.7785 "	9 – 10 "
10	3.98 "	4.2181 "	4 06 "	4.2265 "	10 – 11 "
11	4 28 "	4.2434 "	4.48 "	4.4125 "	11 – 12 "
12	4.47 "	4.5984 "	5.23 "	4.8013 "	12 – 13 "
13	4.98 "	4.7844 "	5.46 "	5.2155 "	13 – 14 "
14	5.58 "	5.1479 "	5.15 "	4.8520 "	over 14 "
15	6.33 "		4.01 "		
16	5.87 "		4.05 "		
17	5.15 "		3.45 "		
18	4.98 "		3.39 "		
19			4.04 "		
20			3.14 "		
21			4.27 "		

The agreement between the series is satisfactory and demonstrates the stability of the method as well as the accuracy with which it has been employed in these particular instances. The coincidence is the more significant because the St. Louis children are taller than the Freiberg children.

TABLE No. 2.

A Comparison of the Average Height Standing of School Children in the Freiberg School District (Geissler and Uhlitzsch) and in the St. Louis Public Schools.

St. Louis Age at Nearest Birthday.	Boys.		Girls.		Freiberg Age.
	St. Louis.	Freiberg.	St. Louis.	Freiberg.	
6	108.94 cm.	108.6 cm.	107.67 cm.	107.9 cm.	6½ to 7 yrs.
7	114.03 "	112.6 "	112.95 "	112.0 "	7 – 8 "
8	119.13 "	117.6 "	118.36 "	116.7 "	8 – 9 "
9	124.35 "	122.1 "	123.67 "	121.5 "	9 – 10 "
10	128.87 "	126.7 "	128.43 "	126.1 "	10 – 11 "
11	133.84 "	130.6 "	133.19 "	131.0 "	11 – 12 "
12	138.21 "	135.5 "	139.11 "	135.5 "	12 – 13 "
13	142.91 "	140.1 "	146.53 "	141.6 "	13 – 14 "
14	148.58 "	144.1 "	150.84 "	145 5 "	over 14
15	154.90 "		155.04 "		
16	160.27 "		157.52 "		
17	165.13 "		159 33 "		
18	170.41 "		159.42 "		
19			158.46 "		
20			159.41 "		
21			159.98 "		

It follows from table No. 1 that *The Physiological Difference between individual school children and the Physical Type of their sex and age is essentially the same, where the differences between the children compared are not greater than those existing between the St. Louis and the Freiberg children.*

The material now to be discussed is presented in Tables No. 6, 7 and 8 and consists of the Number of Observations, Average, Probable Error of Average, Probable Deviation, Relative Annual Increase of Average and Relation of Probable Deviation to Average of Weight in indoor clothing, Height standing without shoes, Height Sitting, *i. e.*, height from the crown of the head to the chair on which the child sits erect, Span of Arms, or distance between the tips of the middle fingers when the arms are extended in a plane with the shoulders, and Girth of Chest, obtained by adding the girth of the chest

on a level with the nipples at full inspiration to the girth at full expiration and dividing by 2, the measurement being made over the boys' shirts and the girls' dresses, the corsets occasionally worn by American school girls being previously removed. The manner of making the measurements is fully described in the author's work On the Growth of St. Louis Children, about to be published by the Academy of Science of St. Louis.

The Absolute Probable Deviation from the Average is given in Table No. 3, extracted from Tables No. 6, 7 and 8. The total deviation of the five dimensions meas-

TABLE No. 3.

THE ABSOLUTE PROBABLE DEVIATION FROM THE AVERAGE: $d = \pm 0.8453 \frac{\Sigma \delta}{n}$

Dimension.	Sex.	Age at nearest Birthday and Absolute Probable Deviation from Average.															
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±
Weight	**Boys.**	**1.43**	**1.68**	**1.96**	**2.09**	**2.23**	**2.60**	**2.46**	**3.88**	**4.56**	**5.06**	**6.16**	**4.38**				
	Girls.	1.44	1.88	1.95	2 23	2.31	2.91	3.31	4.22	4.67	4.05	4.24	3.70	3.60	3.76	3.76	
Height Standing.	**Boys.**	**3.40**	**3.61**	**3.89**	**3.75**	**3.98**	**4.23**	**4.47**	**4.98**	**5.58**	**6.33**	**5.87**	**5.15**	**4.98**			
	Girls.	3.42	3.75	3.70	3.83	4.06	4.48	5.23	5.46	5.15	4.01	4.05	3.45	3.39	4.04	3.14	4.27
Height Sitting	**Boys.**	**2.82**	**2.64**	**2.26**	**2.34**	**2.42**	**2.56**	**2.72**	**2.74**	**3.15**	**3.59**	**3.48**	**3.77**	**2.89**			
	Girls.	2.03	2.19	2.04	2.11	2.19	2.37	2.61	2.87	3.11	2.54	2.36	2.17	1.72	1.82	2.03	1.86
Span of Arms.	**Boys.**	**3.85**	**4.16**	**4.18**	**4.25**	**4.70**	**4.84**	**4.57**	**5.71**	**6.03**	**7.15**	**7.89**	**5.03**	**4.31**			
	Girls.	3.87	4.18	4.28	4.18	4.69	4.87	4.51	5.55	5.29	4.58	4.41	4.05	4.28	4.71	4.13	4.33
Girth of Chest*	**Boys.**	**2.22**	**2.38**	**2.35**	**2.51**	**2.72**	**2.61**	**2.94**	**3.11**	**3.58**	**3.77**	**4.19**	**3.15**	**2.94**			
	Girls.	2.48	2.47	2.40	2.53	2.67	3 04	3.24	3.54	3.65	3.70	3.27	3.34	3.23			
Total ..	**Boys.**	**13.72**	**14.47**	**14.64**	**14.94**	**15.05**	**16.84**	**17.16**	**20.42**	**22.90**	**25.90**	**27.59**	**21.48**				
	Girls.	13.24	14.47	14.37	14.88	15.92	17.67	18.90	21.64	21.87	18.88	18.33	16.71	16.22			

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.

ured at each age is also stated, in order to secure a more accurate general view. It is seen that the total Absolute Probable Deviation increases continuously from age 6 to age 16 in boys and from age 6 to age 15 in girls (except at age 8), after which periods there is a fall. The increase is not uniform, becoming suddenly much greater at age 13 in boys and age 11 in girls, the accelerated increase extending over four years in both sexes and ending as suddenly as it began.

It has been already said that the Absolute Probable Deviation is entangled with the size of the individual. In Table No. 4 this obstacle has been removed and the Physiological Difference of Individual from Type appears. A comparison

TABLE No. 4.

THE RELATION OF PROBABLE DEVIATION (d) TO AVERAGE (A). $\frac{d}{A}$.

Dimension.	Sex.	Age at Nearest Birthday and Relation of Probable Deviation to Average.															
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Weight	**Boys.**	**7.2**	**7.8**	**8.2**	**8.0**	**7.9**	**8.4**	**7.3**	**10.6**	**11.3**	**11.0**	**12.0**	**7.9**	**6.9**			
	Girls.	7.6	9.0	8.5	8.9	8.4	9.6	9.8	11.0	11.0	8.7	8.4	7.0	6.9	7.2	7.0	
Height Standing.	**Boys.**	**3.1**	**3.2**	**3.3**	**3.0**	**3.1**	**3.2**	**3.2**	**3.5**	**3.8**	**4.1**	**3.7**	**3.1**	**2.8**			
	Girls.	3.2	3.3	3.1	3.1	3.1	3.2	3.4	3.8	3.7	3.4	2.6	2.2	2.1	2.6	2.0	2.7
Height Sitting.	**Boys.**	**4.6**	**4.2**	**3.5**	**3.5**	**3.5**	**3.6**	**3.8**	**3.7**	**4.1**	**4.5**	**4.2**	**4.4**	**3.3**			
	Girls.	3 4	3.5	3.2	3.2	3 2	3.4	3.6	3 8	4.0	3.1	2.8	2.6	2.0	2.1	2.4	2.2
Span of Arms.	**Boys.**	**3.5**	**3.6**	**3.5**	**3.4**	**3.6**	**3.6**	**3.2**	**3.9**	**4.0**	**4.5**	**4.8**	**3.0**	**2.5**			
	Girls.	3.6	3.7	3.6	3.4	3.6	3.6	3.2	3.8	3.5	2.9	2.8	2.5	2.7	2.9	2.6	2 7
Girth of Chest*	**Boys.**	**3.8**	**3.9**	**3.8**	**3.9**	**4.1**	**3.9**	**4.3**	**4.4**	**4.9**	**4.9**	**5.3**	**3.9**	**3.5**			
	Girls.	4.3	4.2	3.9	4.0	4.2	4.6	4.7	5.0	4.9	4.7	4.1	4.2	4.0			
Total....	**Boys.**	**22.2**	**22.7**	**22.3**	**21.8**	**22.2**	**22.2**	**21.8**	**26.1**	**28.1**	**29.0**	**30 0**	**22.3**	**19.0**			
	Girls.	22.1	23.7	22.3	22.6	22.5	24.4	24.7	27.4	27.1	22.8	20.7	18.5	17.7			

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.

of this table with the preceding one is very instructive. The continuous increase observed in the Absolute Probable Deviation has disappeared Indeed the total Deviation at age 12 is less than at age 7. An important increase occurs in the years 13, 14, 15 and 16 in boys and 11, 12, 13 and 14 in girls. During these four years in each sex, the Physiological Difference of the Individual from the Type is greater than at any other time. Hence this difference does not increase with the age of the Type or with its size. The true relation of the Physiological Difference is made plain by a comparison of Relative Probable Deviation with Relative Annual Increase of Average

TABLE No. 5.

THE RELATIVE ANNUAL INCREASE OF AVERAGE.*

Dimension.	Sex.	Age at nearest Birthday and Relative Annual Increase of Average.											
		6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18
Weight.....	**Boys.**	**9.7**	**9.7**	**9.6**	**8.7**	**9.5**	**8.1**	**9.3**	**10.5**	**14.3**	**11.6**	**7.9**	**5.3**
	Girls.	10.0	9.9	9.6	9.6	9.7	11.6	14.3	9.9	10.4	7.6	4.7	
Height Standing..	**Boys.**	**4.7**	**4.7**	**4.4**	**3.6**	**3.9**	**3.3**	**3.4**	**4.0**	**4.3**	**3.5**	**3.0**	**3.2**
	Girls.	4.9	4.8	4.5	3.9	3.7	4.4	5.3	2.9	2.8	1.6	1.1	0.06
Height Sitting....	**Boys.**	**3.3**	**2.2**	**3.1**	**3.8**	**2.1**	**2.7**	**2.3**	**3.6**	**3.8**	**3.2**	**4.1**	**3.1**
	Girls.	4.1	3.5	3.4	3.1	2.7	3.8	4.6	3.5	3.5	2.9	1.1	0.6
Span of Arms.....	**Boys.**	**5.0**	**4.9**	**4.3**	**4.0**	**3.8**	**4.1**	**3.2**	**4.3**	**4.7**	**3.5**	**2.8**	**4.0**
	Girls.	5.0	5.3	4.5	4.1	4.3	4.3	5.1	3.7	2.5	1.4	3.2	0.9
Girth of Chest†...	**Boys.**	**2.7**	**2.6**	**2.8**	**2.6**	**2.5**	**2.3**	**2.7**	**3.8**	**4.5**	**3.5**	**2.7**	**3.8**
	Girls.	1.9	2.3	2.8	0.8	4.5	3.8	4.3	4.0	3.6	2.7	2.0	0.1
Total.....	**Boys.**	**25.4**	**24.1**	**24.2**	**22.7**	**21.8**	**20.5**	**20.9**	**26.2**	**31.6**	**25.3**	**20.5**	**19.4**
	Girls.	25.9	25.8	24.8	21.5	24.9	27.9	33.6	24.0	22.8	16.2	12.1	1.7

* Obtained for age 6 to 7 by dividing the increase from age 6 to age 7 by the average at age 6; for age 7 to 8 by dividing the increase from age 7 to age 8 by the average at age 7; and so on.

† Obtained by adding Girth of chest at full inspiration to Girth of chest at full expiration and dividing by 2.

or quickness of growth, given in Table No. 5. The comparison is made easy by arranging the totals side by side. The

AGE.	Relative Probable Deviation.	Relative Increase of Average.	Relative Probable Deviation.	Relative Increase of Average.
	BOYS.	BOYS.	GIRLS.	GIRLS.
6	22.2	.....	22.1	.....
7	22.7	25.4	23.7	25.9
8	22.3	24.1	22.3	25.8
9	21.8	24.2	22.6	24.8
10	22 2	22.7	22.5	21.5
11	22.2	21.8	**24.4**	**24.9**
12	21.8	20.5	**24.7**	**27.9**
13	**26.1**	**20.9**	**27.4**	**33.6**
14	**28.1**	**26.2**	**27.1**	**24.0**
15	**29.0**	**31.6**	22.8	22.8
16	**30.0**	**25.3**	20.7	16.2
17	22.3	20.5	18.5	12.1
18	19.0	19.4	17.7	1.7

comparison reveals in both cases a general though not unbroken fall from age 7 to age 13 in boys and 11 in girls, a remarkable increase covering four years in both sexes, and a subsequent great decline. Thus the Relative Deviation coincides in the main with the Quickness of Growth. This relation is shown graphically in Plate I.

The phenomena just described are here seen to advantage. The curve of rate of growth in boys (unbroken red line) falls from age 7 to 12, corresponding to a small fall in Probable Deviation (unbroken black line). At age 12 to 13, a sudden change appears in both curves. They rise rapidly, reach a high maximum and suddenly fall to their former level. The period from the beginning of the rise to the return to the level of age 12 has the same duration in both curves. The maximum deviation is greater in Relative Anuual Increase than in Relative Probable Deviation, a fact in accord with the greater stability of the latter, and the maximum Annual Increase occurs a little earlier than the maximum Probable Deviation. The period of acceleration is more sharply defined in Annual Increase. At age 18, both curves are still falling. The relation between the Rate of Growth

VOL. VI. NO. 10. PLATE I (from Tables No. 4 and 5).

Black: Relative Probable Deviation.
Red: Relative Annual Increase of Average.

Unbroken Curves: Boys.
Broken Curves: Girls.

and Probable Deviation is even more clearly seen in the girls' curves (broken lines). The rapid rise begins in them at age 10 to 11, and reaches its maximum at the same age in both curves. The subsequent fall is profound.

The evidence presented above permits the conclusion: *The Physiological Difference between the individual children in an anthropometric series and the Physical Type of the series is directly related to the Quickness of Growth.*

TABLE No. 6.

Data of Height Standing and Weight.

Age at Nearest Birthday.	Sex.	Height Standing (In Centimetres).						Weight (In Kilograms).					
		Number of Observations.	Average. A	Probable Error of Average. E	Probable Deviation. d	Relative Annual Increase of Average.	Relation of Probable Deviation to Average. $\frac{d}{A}$	Number of Observations.	Average. A	Probable Error of Average. E	Probable Deviation. d	Relative Annual Increase of Average.	Relation of Probable Deviation to Average. $\frac{d}{A}$
				±	±	%	%			±	±	%	%
Six	**Boys.**	**709**	**108.94**	**0.128**	**3.40**		**3.1**	**707**	**19.75**	**0.054**	**1.43**		**7.2**
	Girls.	780	107.67	0.123	3.42		3.2	798	18.93	0.051	1.44		7.6
Seven	**Boys.**	**1850**	**114.03**	**0.084**	**3.61**	**4.7**	**3.2**	**1814**	**21.67**	**0.039**	**1.68**	**9.7**	**7.8**
	Girls.	1791	112.95	0.089	3.75	4.9	3.3	1714	20.82	0.045	1.88	10.0	9.0
Eight	**Boys.**	**2223**	**119.13**	**0.082**	**3.89**	**4.7**	**3.3**	**2188**	**23.78**	**0.042**	**1.96**	**9.7**	**8.2**
	Girls.	2193	118.36	0.079	3.70	4.8	3.1	2147	22.88	0.042	1.95	9.9	8.5
Nine	**Boys.**	**2205**	**124.35**	**0.080**	**3.75**	**4.4**	**3.0**	**2188**	**26.06**	**0.045**	**2.09**	**9.6**	**8.0**
	Girls.	2122	123.67	0.065	3.83	4.5	3.1	2055	25.08	0.049	2.23	9.6	8.9
Ten	**Boys.**	**2087**	**128.87**	**0.087**	**3.98**	**3.6**	**3.1**	**2064**	**28.32**	**0.049**	**2.23**	**8.7**	**7.9**
	Girls.	2053	128.43	0.089	4.06	3.9	3.1	1947	27.49	0.052	2.31	9.6	8.4
Eleven	**Boys.**	**1819**	**133.84**	**0.099**	**4.23**	**3.9**	**3.2**	**1743**	**31.00**	**0.062**	**2.60**	**9.5**	**8.4**
	Girls.	1772	133.19	0.106	4.48	3.7	3.2	1708	30.15	0.070	2.91	9.7	9.6
Twelve	**Boys.**	**1653**	**138.21**	**0.116**	**4.47**	**3.3**	**3.2**	**1644**	**33.51**	**0.061**	**2.46**	**8.1**	**7.3**
	Girls.	1732	139.11	0.098	5.23	4.4	3.4	1676	33.66	0.081	3.31	11.6	9.8
Thirteen	**Boys.**	**1268**	**142.91**	**0.140**	**4.98**	**3.4**	**3.5**	**1242**	**36.61**	**0.110**	**3.88**	**9.3**	**10.6**
	Girls.	1322	146.53	0.150	5.46	5.3	3.8	1343	38.49	0.115	4.22	14.3	11.0
Fourteen	**Boys.**	**925**	**148.58**	**0.183**	**5.58**	**4.0**	**3.8**	**946**	**40.44**	**0.148**	**4.56**	**10.5**	**11.3**
	Girls.	1085	150.84	0.156	5.15	2.9	3.7	1082	42.29	0.142	4.67	9.9	11.0
Fifteen	**Boys.**	**490**	**154.90**	**0.286**	**6.33**	**4.3**	**4.1**	**498**	**46.22**	**0.227**	**5.06**	**14.3**	**11.0**
	Girls.	680	155.04	0.154	4.01	2.8	3.4	690	46.69	0.154	4.05	10.4	8.7
Sixteen	**Boys.**	**189**	**160.27**	**0.427**	**5.87**	**3.5**	**3.7**	**203**	**51.60**	**0.431**	**6.16**	**11.6**	**12.0**
	Girls.	420	157.52	0.197	4.05	1.6	2.6	420	50.25	0.207	4.24	7.6	8.4
Seventeen	**Boys.**	**78**	**165.13**	**0.592**	**5.15**	**3.0**	**3.1**	**71**	**55.67**	**0.521**	**4.38**	**7.9**	**7.9**
	Girls.	206	159.33	0.241	3.45	1.1	2.2	230	52.61	0.244	3.70	4.7	7.0
Eighteen	**Boys.**	**29**	**170.41**	**0.924**	**4.98**	**3.2**	**2.8**	**17**	**58.64**			**5.3**	
	Girls.	164	159.42	0.265	3.39	0.06	2.1	155	52.36	0.289	3.60		6.9
Nineteen	Girls.	85	158.46	0.438	4.04		2.6	81	52.19	0.332	3.76		7.2
Twenty	Girls.	79	159.41	0.346	3.14		2.0	66	53.91	0.565	3.76		7.0
Twenty-one	Girls.	43	159.98	0.651	4.27		2.7						

TABLE No. 7.

Data of Height Sitting and Span of Arms.

Age at Nearest Birthday.	Sex.	Height Sitting (In Centimetres).						Span of Arms (In Centimetres).					
		Number of Observations.	Average. A	Probable Error of Average. E	Probable Deviation. d	Relative Annual Increase of Average.	Relation of Probable Deviation to Average. $\frac{d}{A}$	Number of Observations.	Average. A	Probable Error of Average. E	Probable Deviation. d	Relative Annual Increase of Average.	Relation of Probable Deviation to Average. $\frac{d}{A}$
				±	±	%	%			±	±	%	%
Six	**Boys.**	**714**	**61.31**	**0.105**	**2.82**		**4.6**	**708**	**108.95**	**0.144**	**3.85**		**3.5**
	Girls.	751	59.45	0.132	2.03		3.4	769	106.96	0.140	3.87		3.6
Seven	**Boys.**	**1853**	**63.32**	**0.061**	**2.64**	**3.3**	**4.2**	**1862**	**114.42**	**0.096**	**4.16**	**5.0**	**3.6**
	Girls.	1727	61.80	0.053	2.19	4.1	3.5	1724	112.36	0.107	4.18	5.0	3.7
Eight	**Boys.**	**2239**	**64.74**	**0.048**	**2.26**	**2.2**	**3.5**	**2234**	**120.07**	**0.088**	**4.18**	**4.9**	**3.5**
	Girls.	2120	63 97	0.044	2.04	3.5	3.2	2152	118.33	0.092	4.28	5.3	3.6
Nine	**Boys.**	**2258**	**66.73**	**0.049**	**2.34**	**3.1**	**3.5**	**2272**	**125.18**	**0.089**	**4.25**	**4.3**	**3.4**
	Girls.	2071	66.16	0.046	2.11	3.4	3.2	2065	123.63	0.092	4.18	4.5	3.4
Ten	**Boys.**	**2118**	**69.25**	**0.040**	**2.42**	**3.8**	**3.5**	**2076**	**130.22**	**0.103**	**4.70**	**4.0**	**3.6**
	Girls.	2037	68.19	0.049	2.19	3.1	3.2	2045	128.75	0.104	4.69	4.1	3.6
Eleven	**Boys.**	**1828**	**70.67**	**0.060**	**2.56**	**2.1**	**3.6**	**1810**	**135.13**	**0.113**	**4.84**	**3.8**	**3.6**
	Girls.	1748	70.03	0.057	2.37	2.7	3.4	1757	134.24	0.116	4.87	4.3	3.6
Twelve	**Boys.**	**1656**	**72.55**	**0.067**	**2.72**	**2.7**	**3.8**	**1664**	**140.60**	**0.112**	**4.57**	**4.1**	**3.2**
	Girls.	1707	72.67	0.063	2.61	3.8	3.6	1718	140.07	0.109	4.51	4.3	3.2
Thirteen	**Boys.**	**1285**	**74.20**	**0.076**	**2.74**	**2.3**	**3.7**	**1281**	**145.09**	**0.159**	**5.71**	**3.2**	**3.9**
	Girls.	1354	76.03	0.078	2.87	4.6	3.8	1368	147.19	0.150	5.55	5.1	3.8
Fourteen	**Boys.**	**936**	**76.84**	**0.103**	**3.15**	**3.6**	**4.1**	**934**	**151.28**	**0.197**	**6.03**	**4.3**	**4.0**
	Girls.	1065	78.68	0.095	3.11	3.5	4.0	1088	152.58	0.160	5.29	3.7	3.5
Fifteen	**Boys.**	**498**	**79.74**	**0.161**	**3.59**	**3.8**	**4.5**	**495**	**158.43**	**0.321**	**7.15**	**4.7**	**4.5**
	Girls.	674	81.42	0.098	2.54	3.5	3.1	677	156.38	0.176	4.58	2.5	2.9
Sixteen	**Boys.**	**193**	**82.28**	**0.250**	**3.48**	**3.2**	**4.2**	**189**	**163.96**	**0.574**	**7.89**	**3.5**	**4.8**
	Girls.	411	83.76	0.116	2.36	2.9	2.8	413	158.51	0.217	4.41	1.4	2.8
Seventeen	**Boys.**	**77**	**85.68**	**0.427**	**3.77**	**4.1**	**4.4**	**75**	**168.56**	**0.581**	**5.03**	**2.8**	**3.0**
	Girls.	202	84.66	0.153	2.17	1.1	2.6	202	159.01	0.285	4.05	3.2	2.5
Eighteen	**Boys.**	**31**	**88.23**	**0.536**	**2.89**	**3.1**	**3.3**	**32**	**175.31**	**0.761**	**4.31**	**4.0**	**2.5**
	Girls.	167	85.20	0.133	1.72	0.6	2.0	164	160.47	0.334	4.28	0.9	2.7
Nineteen	Girls.	85	84.86	0.198	1.82		2.1	83	158.45	0.517	4.71		2.9
Twenty	Girls.	78	85.31	0.230	2.03		2.4	76	160.17	0.474	4.13		2.6
Twenty-one	Girls.	41	85.05	0.290	1.86		2.2	37	161.27	0.712	4.33		2.7

TABLE No. 8.
Data of Girth of Chest.

Age at Nearest Birthday.	Sex.	Girth of Chest* (In Centimetres). Number of Observations.	Average. A	Probable Error of Average. E	Probable Deviation. d	Relative Annual Increase of Average.	Relation of Probable Deviation to Average. $\frac{d}{A}$
				±	±	%	%
Six	**Boys.**	**677**	**59.05**	**0.083**	**2.22**		**3.8**
	Girls.	741	58.34	0.091	2.48		4.3
Seven	**Boys.**	**1708**	**60.62**	**0.057**	**2.38**	**2.7**	**3.9**
	Girls.	1631	59.47	0.062	2.47	1.9	4.2
Eight	**Boys.**	**2095**	**62.18**	**0.052**	**2.35**	**2.6**	**3.8**
	Girls.	2040	60.81	0.053	2.40	2.3	3.9
Nine	**Boys.**	**2120**	**63.90**	**0.055**	**2.51**	**2.8**	**3.9**
	Girls.	1966	62.51	0.057	2.53	2.8	4.0
Ten	**Boys.**	**1997**	**65.59**	**0.061**	**2.72**	**2.6**	**4.1**
	Girls.	1893	63.02	0.061	2.67	0.8	4.2
Eleven	**Boys.**	**1732**	**67.24**	**0.063**	**2.61**	**2.5**	**3.9**
	Girls.	1654	65.85	0.075	3.04	4.5	4.6
Twelve	**Boys.**	**1565**	**68.76**	**0.074**	**2.94**	**2.3**	**4.3**
	Girls.	1624	68.34	0.081	3.24	3.8	4.7
Thirteen	**Boys.**	**1228**	**70.61**	**0.089**	**3.11**	**2.7**	**4.4**
	Girls.	1313	71.29	0.098	3.54	4.3	5.0
Fourteen	**Boys.**	**925**	**73.27**	**0.118**	**3.58**	**3.8**	**4.9**
	Girls.	1020	74.13	0.114	3.65	4.0	4.9
Fifteen	**Boys.**	**498**	**76.56**	**0.169**	**3.77**	**4.5**	**4.9**
	Girls.	659	76.78	0.143	3.70	3.6	4.7
Sixteen	**Boys.**	**205**	**79.22**	**0.293**	**4.19**	**3.5**	**5.3**
	Girls.	397	78.85	0.164	3.27	2.7	4.1
Seventeen	**Boys.**	**80**	**81.39**	**0.353**	**3.15**	**2.7**	**3.9**
	Girls.	206	80.39	0.233	3.34	2.0	4.2
Eighteen	**Boys.**	**31**	**84.52**	**0.528**	**2.94**	**3.8**	**3.5**
	Girls.	162	80.45	0.254	3.23	0.1	4.0

* Obtained by adding Girth of Chest at full Inspiration to Girth of Chest at full Expiration and dividing by 2.

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CATALOGUE OF REPTILES AND BATRACHIANS FOUND IN THE VICINITY OF ST. LOUIS, MO.

JULIUS HURTER.

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The following catalogue is intended to give some additional data concerning the geographical distribution of these animals.

Within the last few years the writer has found some 62 species in the county of St. Louis, Mo., and in the adjacent counties across the river from St. Louis; St. Clair and Madison Counties, Ills.

It is mainly the low lands or the so-called "American Bottom" along the river in these two last named counties that afford a good opportunity for collecting certain species that make their abode in or near water.

The principal sources of information in preparing my list, together with my own observations for many years, are as follows:—

First. The descriptive catalogue of American Reptilia and Batrachia found east of the Mississippi river, by N. S. Davis, Jr., and Frank L. Rice, 1883.

Second. A synopsis of the reptiles and batrachia of Illinois by H. Garman, 1892.

Third. Bulletin No. 24 of the U. S. National Museum; a check list of North American reptiles and batrachia with catalogue of specimens in the U. S. National Museum by H. C. Yarrow, M. D., which gives credit to Dr. George Engelmann of St. Louis, for a number of contributions sent by him to the National Museum. I am also very much indebted to Dr. Leonhard Stejneger, curator of the reptiles of the Smithsonian Institute of Washington, D. C., for the identification of a number of specimens. Before proceeding any further, I wish to call the attention of the academy to the fact that many of the States have included in their geological reports a report on the reptiles and batrachia of their respective States, such as Illinois, Indiana, etc.

If the same proceeding could be resorted to in this State, it would furnish additional information so desirable in this particular branch of science.

CLASS BATRACHIA.

Order Urodela.

Family Sirenidae. Sirens.

1. *Siren Lacertina.* (Linn.) Mud-eel.

Found in lakes and sloughs near Falling Spring, St. Clair County, Ill. This animal is rather scarce and is becoming more so, as its abodes have been drained in the last few years.

Family Proteidae. Water Dogs.

2. *Necturus Maculatus.* (Raf.) Mud-puppy, Water-dog.

Common in the Mississippi and Merrimac rivers, and in the lakes and ponds adjoining the former, in St. Clair County, Ill., and Madison County, Ill., which are inundated nearly every spring.

During early spring and late fall they leave the deep water to approach the shores and are then often caught with hook and line by fishermen, who dread them, claiming that they are very poisonous, although the fact is, they are as harmless as a frog. They are commonly called "Water-dogs" on account of their gills on the side of the neck, which look like ears when the animal is out of water. I have kept two of them for several months in an aquarium, but one morning found them both dead through suffocation, owing to the larger one, some fourteen inches long, having more than half swallowed the smaller one, which was about ten inches long.

AMBLYSTOMIDAE. SALAMANDER.

3. *Amblystoma Microstomum.* (Cope.) Small-mouthed Salamander.

This animal is found sparingly in spring, under rocks and logs at Cliff Cave, St. Louis County; also near Bluff Lake, St. Clair County, Ill.

4. *Amblystoma Tigrinum.* (Green.) Tiger Salamander.

This is the most common salamander near St. Louis. It is found under logs and rocks and very often in the cellars in the city. The average length of these salamanders is about six inches, but I have captured specimens as long as ten inches. Found also in St. Clair and Madison Counties, Ill.

Family Plethodontidae.

5. *Plethodon Glutinosus.* (Green.) Slimy Salamander.

This species is common in spring. It is usually found in the vicinity of bluffs, under rocks and logs near springs and small creeks. Toward the middle of summer when the weather becomes very hot they usually disappear. Found at Cliff Cave, St. Louis County and St. Clair County, Ill.

6. *Spelerpes Longicaudus.* (Green.) Long-tailed or Cave Salamander.

This is another species also quite common in the same surroundings as the last one. The writer has not yet been successful in finding one of these

specimens in a cave, although it is called the "Cave salamander." Found at Cliff Cave, St. Louis County, and Bluff Lake, St. Clair County, Ill.

Family Pleurodelidae.

7. *Diemyctylus Viridescens.* (Raf.) Red Eft or Newt.

I made my first acquaintance with this very interesting little animal on a shady slope of the bluffs near Bluff Lake, St. Clair County, Ill. The animal was in its first stage, the terrestrial form known as D. Miniatus or Red Eft. A year after I captured the adult animal D. Viridescens or Newt with a dip net in the neighboring lake. I have caught them in all stages and came to the conclusion that they must be all one and the same animal. I have taken a number of these small "Red Efts" home and placed them in my aquarium, when I found that some of them went readily into the water, while others, generally the smallest or youngest ones of the lot, would climb out of the water in the corners of the aquarium and remain there until I forced them down again into the water, which, it seemed, did not agree with them as they died about a week after they were confined to the aquarium. Of fifteen specimens that I placed in the aquarium four died; the surviving ones grew very stout, but it was not before the following spring that they commenced to develop into the adult or Viridescens form. A year after they were put in the aquarium they mated and the female deposited her spawn against the glass plates where it was devoured by some young cat fish. Later in the fall the remaining specimens lost their nuptial appendages. The following spring they developed anew.

Order Salientia. Tailless Batrachia.

Family Bufonidae.

genus bufo. (Laurenti.) toads.

8. *Bufo Lentiginosus Americanus.* (LeConte.)

The common American toad is found everywhere in congenial places. Notwithstanding some people have such a repugnance for these animals, they are very useful to the husbandman, by devouring a great many insects and larvae, and ought not to be killed as many persons do whenever they see them. It is when closely observed, very lively and from the appearance of its eye, a very intelligent animal and makes a nice pet.

genus engystoma. (Fitzinger.)

9. *Engystoma carolinense.* (Holbrook.) The Nebulous Toad.

This little toad is quite rare. I have only found it in spring at Cliff Cave, St. Louis County, Mo., nearly on the top of a bluff on the southwestern exposure. They are not easily seen on account of their color and being partially hid in the ground, under rocks and logs.

Family Hyldae. Tree Frogs.

genus acris. (Dum & Brib.)

10. *Acris Gryllus Crepitans.* (Baird.) Western Cricket-frog.

This species is the most common of all little frogs. It is found near pools and creeks, where it generally sits on the banks so as to resort to the water when alarmed. It can make jumps from three to four feet long.

GENUS CHOROPHILUS.

11. *Chorophilus Triseriatus.* (Prince Max De Wied.) Striped Tree Frog.

This is one of the nicest marked of the small frogs, found generally in early spring in the ditches along the country roads, Wet Prairie, Madison County, Ill., and near Bluff Lake, St. Clair County, It is often seen during harvesting season and for that reason farmers call it the "Hay Frog."

GENUS HYLA. (Laurenti.)

12. *Hyla Versicolor.* (LeConte.) The Common Tree Frog.

The most common of our tree frogs; it is found on trees and fences where there is a convenient hiding-place, and by its ability to change its color more or less to suit its surroundings, it is not easily found, although a person familiar with its voice can find it without much trouble.

13. *Hyla Carolinensis.* (Penn.) Cinereous Frog. Green Tree Frog.

Up to the present time I have found only one of this species, adhering to a large leaved water plant at the border of Cantine Creek, Cantine, Madison County, Ill.

14. *Hyla Pickeringi.* (Holbrook.) Piping Tree Frog.

This little frog can be readily recognized by the X mark on its back. It is often found in early spring near the lakes and sloughs in St. Louis County Mo., and St. Clair County, Ill.

FAMILY RANIDÆ.

GENUS RANA. (Linn.) FROGS.

15. *Rana Pipiens.* (Gmel.) Leopard Frog.

This is a very common frog and one that makes its appearance in spring as soon as the ice has disappeared. It is sometimes found quite a distance from water, in St. Louis County, Mo., and Madison and St. Clair Counties, Ill.

16. *Rana Palustris.* (LeConte.) Swamp Frog.

This species is not so often seen as it prefers small creeks fed by spring water near the bluffs, Cliff Cave, St. Louis County, Mo., and Bluff Lake, St. Clair County, Ill.

17. *Rana clamata.* (Daudin.) Green Frog.

This frog has more of an aquatic habit than either the leopard or swamp frog. It is found in pools and lakes both in Missouri and Illinois.

18. *Rana Catesbiana.* (Shaw.) Bull Frog.

This is a common frog in the neighborhood of St. Louis and across the river in Illinois. I have seen specimens 6¾ inches long, head and body. They are often sought for the table, and by many considered a delicacy.

19. *Rana Sylvatica.* (LeConte.) Wood Frog.

Up to the present time I have been unable to find one of this species, but have included it on the authority of Dr. Geo. Engelmann, St. Louis, who has presented the U. S. National Museum with one specimen, No. 3453 Yarrow's Catalogue, Bulletin No. 24.

CLASS REPTILIA.

NON-POISONOUS SNAKES.

FAMILY COLUBRIDAE.

Order Ophidia. Snakes.

GENUS CARPHOPHIS. (Gervais.)

1. *Carphophis amoena.* (Say.) Ground Snake.

I have found only one specimen up to the present time under a rock on the top of a bluff covered with grass near Canion Spring, St. Louis County, Mo.

2. *Carphophis Helenae.* (Kennicott.) Helen's Snake.

Another small snake which can be distinguished at once when alive without referring to the scales of the head by its peculiar appearance, on account of which I would consider it a variety of the following species described below. It is also found under rocks and stumps in St. Louis County, Mo., as well as St. Clair County, Ill.

3. *Carphoris Vermis.* (Kenn.) The Western Ground or Worn Snake.

Is the most common of ground snakes and is found in the mould of tree stumps and under rocks, in St. Louis County, Mo., and St. Clair County, Ill.

GENUS VIRGINIA. (B. & G.)

4. *Virginia Elegans.* (Kenn.) Virginia's Snake.

This rare small snake is mostly always found under rock, although one specimen I captured gliding over a foot-path in day-time in a heavy timbered locality. Found in St. Louis County, Mo. and Bluff Lake, St. Clair County, Ill. This snake is viviparous.

GENUS OPHIBOLUS (B. & G.)

5. *Ophibolus Doliatis.* (Linn.) Scarlet King Snake.

A nice colored snake quite often found under rocks and in decaying logs. They have a great relish for lizards and snakes. Found in St. Louis County, Mo., and St. Clair County, Ill.

6. *Ophibolus Calligaster.* (Say.) Evan's King Snake.

Two specimens found April 2d, 1893, the first warm day of the season, on a small sloping prairie near Walnut Park, city of St. Louis, and one specimen found at Highland, Madison County, Ill., same having been plowed out of the ground. When irritated they vibrate their tails, which when striking against some dry wood, will produce a rattling noise similar to that of a rattle snake.

7. *Ophibolus Getulus Say.* (Holbrook.) Say's King Snake.

May be found occasionally under logs and rocks and like other members of this genus feeds on lizards and snakes. In keeping a specimen of Ophibolus Getulus (Linn), in captivity, which was about four feet six inches long, I was astonished to find one morning that it had swallowed a coluber obsoletus some five feet, three inches long, thereby leaving it so rigid in the shape of a half circle that it remained when handled in the same rigid

form for several days. The tail of its victim was doubled up, which spread the neck in such a way as to give the chainsnake the appearance of a cobra. About a week later she disgorged the undigested parts of the snake which was only the skin and bones, after which she was as lively as before.

GENUS DIADOPHIS. (B. & G.)

8. *Diadophis Arnyi.* (Kenn.) The Ringneck Snake.

Is one of the most common of small snakes and like nearly all of the snakes, they make their abode under rocks and logs. Have found as many as fourteen under one rock. Found in St. Louis County, Mo., and St. Clair County, Ill.

GENUS PHYLLOPHILOPHIS. (S. Garman.)

9. *Phillophilophis Aestivus.* (Linn.) Keeled Green Snake.

A nice slender green snake, resembling a tree snake, which is rather scarce. Some of my friends (entomologists) capture them occasionally in their nets while mowing bushes and small trees for insects. Have captured one at Allenton, St. Louis County, Mo., and one near Mascoutah, St. Clair County, Ill.

GENUS COLUBER.

10. *Coluber Obsoletus Obsoletus.* (Cope.) Mountain Black Snake or Pilot Snake.

This snake is more common than the genuine black snake, and makes its abode in standing hollow trees and under rocks and decaying logs. I find this snake of a more vicious disposition, notwithstanding the observations of other collectors. It also vibrates its tail when irritated. One specimen that I kept in confinement, caught mice and sparrows by coiling itself around its prey in a moment's time, so that only the head was visible, when it would commence to swallow it by beginning at the head of its prey and loosening its coils as it proceeded to devour it. Mostly found in the neighborhood of bluffs, Missouri and Illinois.

GENUS BASCANION. (B. & G.)

11. *Bascanion Constrictor.* (Linn.) The Common Black Snake or "Blue Racer."

This snake is getting rather scarce, owing to the cultivation of the low grounds and its preference for meadows. Often found on the top of blackberry bushes, sunning itself. Had once the opportunity to see this snake race; so fast did it glide down a hill, over rocks and weeds, to seek its hiding place amongst the roots of a large tree, that it required a race on my part to secure it.

GENUS EUTAINIA. (B. AND G.)

12. *Eutainia Faireyi.* (B. & G.) Fairie's Ribbon Snake.

It is quite common near St. Louis on both sides of the Mississippi river in the swamps and ponds and low lands.

13. *Eutainia Radix.* (B. & G.) The Racine Garter Snake.

Have found them only in the ditches filled with water along the road at Wet Prairie, Madison County, Ill., where they are rather common.

14. *Eutainia Sirtalis Sirtalis.* (Cope.) The Common Garter Snake.

The most common snake in the neighborhood of St. Louis, on both sides of the river. It is one of the kind that leaves its winter quarters the first warm day in spring, and at the same time is one of the last to hibernate in fall.

GENUS STOREERIA. (B. & G.)

15. *Storeria De Kayi.* (Holbrook.) De Kay's Brown Snake.

A small snake that is mostly found near swamps and ponds, but is rather scarce. Found in St. Louis County, Mo., and St. Clair County, Ill.

16. *Storeria Occipito-Maculata.* (Storer.) Storer's Snake.

Another small snake not frequently met with. So far have found only two, one at Allenton, St. Louis County, Mo., and one in Iron County, Mo.

GENUS TROPIDOCLONIUM. (Cope.)

17. *Tropidoclonium Lineatum.* (Hallowell.) The Lined Snake.

A plain looking snake resembling a garter snake; found along the river front in an abandoned quarry near the Arsenal grounds, in city of St. Louis. They are found under rocks and under sods. In 1892 during the big inundations, I have found hundreds of them drowned and washed against the settling basins of the St. Louis water-works at Bissel's Point. They came all from a tract of low land above the water-works, about 1½ miles long by about 600 feet wide. This place is covered with rank grass, and in dry weather the ground which is of a boggy kind of black earth, cracks in all directions, thereby forming hiding places for these snakes.

GENUS NATRIX. (Laurenti.)

18. *Natrix Grahami.* (B. & G.) Graham's Queen Snake.

An abundant water snake in the low lands along both sides of the Mississippi river.

19. *Natrix Sipedon.* (Linn.) The Common Water Snake of this neighborhood.

It is known by the farmers as the water moccasin, owing to its close resemblance to that poisonous snake, at the same time it is not venomous. Found in sloughs, ponds and low creeks.

20. *Natrix Sipedon Erythro-Gaster.* (Shaw.) The Red Bellied Water Snake.

It is not often met with. They vary considerable in color on the belly, having found some with only a yellowish tint, in Bluff Lake, St. Clair County, Ill. Those of Fox Creek near Allenton, St. Louis County, Mo., are of the regular color.

21. *Natrix Sipedon Woodhousei.* (B. & G.) Woodhouse Water Snake.

Another snake that I found only near Bluff Lake and in a place called "Dead Creek" near Cahokia, St. Clair County, Ill.

22. *Natrix Rhombifera.* (Hallowell.) The Diamond Water Snake.

Is a rather common snake on both sides of the Mississippi river, in all back waters, sloughs and ponds.

GENUS HETERODON. (Beauv.)

23. *Heterodon Platirhinos.* (Latr.) The Blowing Adder or Spreading Adder.

Is quite a common snake both in Missouri and Illinois. They are generally found near water and feed on frogs. Some are nicely spotted, others are nearly uniform in color, and were on that account formerly separated as two distinct species.

THE POISONOUS SNAKES.

Family Crotalidae.

GENUS AGKISTRODON. (Beauv.)

24. *Agkistrodon Contortrix.* (Linn.) The Copperhead.

Not an uncommon Snake in St. Louis County, Mo. It is found under rocks and logs, generally in a shady locality, and mostly in the neighborhood of water. They also vibrate their tails, and when striking against some dry leaves it will make a rattling noise. These snakes are vicious and always ready to bite. They are very poisonous, but the researches of Drs. Mitchell & Reichert show that their venom is less virulent than that of the rattle snake, but more so than the water moccasin, which is found farther south in the State of Missouri.

GENUS SISTRURUS. (Garman.)

25. *Sistrurus Catenatus.* (Raf.) The Prairie Rattle Snake Massasauga.

So far I have found this snake only on what is known as the "Wet Prairie," near Edwardsville, Madison County, Ills. With the first warm days in April they come out of their winter quarters to sun themselves when they are then very often seen and killed by the hunters shooting snipe. The farmers destroy many of them while plowing their fields. I know of a place where a farmer plowed up seven large snakes out of a piece of ground not over 200 feet long by 8 feet wide.

GENUS CROTALUS. (Linn.) RATTLE SNAK S.

26. *Crotalus Horridus.* (Linn.) The Common Rattle Snake or the Timber Rattle Snake. Serpent a sonnette of the French and Klapper Schlange of the Germans.

Years ago this snake was rather scarce in St. Clair County, Ill., as in those days there was no stock law, and the pigs roamed around and exterminated a good many snakes, but since the stock law has gone into effect, compelling swine to be penned up, the snakes have become more numerous again. In early spring they are found near the bluffs under rocks, but later on they go to the wheat fields and meadows, where they are very safe till harvest time, when a good many are destroyed by the farm hands.

Order Lacertilia. (*Lizards.*)

Family Scincidae.

GENUS LYGOSOMA. (Gray.)

27. *Lygosoma Laterale.* (Say.) The Ground Lizard.

Up to the present time I have only found two specimens of this nimble lizard at Cliff Cave, St. Louis County, Mo. They were found under rocks.

To my knowledge this is about the most northern locality recorded for this species. In the southern States this lizard is quite common, and is often found under the detached barks of trees and under decaying logs.

GENUS EUMECES. (Wiegmann.)

28. *Eumeces Fasciatus.* (Linn.) The Blue Tailed Lizard or "Scorpion."

An abundant and very variable lizar . The young have five yellowish streaks on the back, and the tail is of a bright blue color; in older specimens the stripes are very faint, often wanting; and in the spring the head of the old males becomes of a coppery red. On one occasion I brought home a female of this species which I transferred to my Vivarium, where in a short time it deposited its eggs, six in number, in a small cavity in the sand under a rock. Whenever I lifted the rock, I found the lizard coiled around its eggs, which made it appear as if she was hatching them. In due time all the eggs were hatched, and I had six nice small blue-tailed lizards, quite different in color from the old female. On account of not being able to procure the proper food for them, they soon died.

FAMILY TEIDAE.

GENUS CNEMIDOPHORUS. (Wiegmann.)

29. *Cnemidophorus Sex-Lineatus.* (Linn.) The Six-Lined Lizard.

The swiftest of all the lizards in this neighborhood. They like high and dry stony localities. They are not generally distributed as some of the other lizards; they live more in colonies in St. Louis County, Mo., and on the bluffs near Bluff Lake, St. Clair County, Ill.

FAMILY ANGUIDAE.

GENUS OPHIOSAURUS. (Daud).

30. *Ophiosaurus Ventralis.* (Linn.) Glass Snake or Joint Snake.

This lizard has the appearance of a snake and is very rare in this neighborhood. I never had the opportunity to capture any, but had one presented to me by Mr. Otto Widman of St. Louis, who had four specimens given to him that were caught near the City Workhouse.

FAMILY IGUANIDAE.

GENUS SCELOPORUS. (Wieg.)

31. *Sceloporus Undulatus.* (Bosc.) The Alligator Lizard.

The most common of lizards in this neighborhood. One might find them under almost any rock pile. They live also under logs and in hollow trees. When penned in the woods, they effect their escape by climbing trees. Found in St. Louis County, Mo.

Order Chelonia Turtles.

SUB-ORDER TRIONYCHOIDEA.

FAMILY TRIONYCHIDAE.

GENUS TRIONYX. (Geoff.)

32. *Trionyx-Muticus.* (Le S.) Soft shell or Leather Turtle.

This is the common soft shell turtle found in the Mississippi river near St. Louis. About the third week in June they generally deposit their eggs on the sandbars in the river.

33. *Trionyx Spiniferus.* (Le S.) The Spiny Soft Shell Turtle.

Not quite so abundant as the preceding one, but still often enough met with. Found in the Mississippi river, Merimac river and Illinois river.

SUB-ORDER TESTUDINATA.

FAMILY CHELYDRIDAE.

GENUS CHELYDRA. (Schweigger.)

34. *Chelydra Serpentina.* (Linn.) The Snapping Turtle.

A common turtle; found in the river, creeks, ponds and sloughs in Missouri and Illinois. Old specimens are sometimes so covered with moss, that they have the appearance of a rock in water. I have seen specimens weighing as much as 24 pounds.

GENUS MACROCLEMYS. (Gray.)

35. *Macroclemys Temminkii.* (Troost.) Alligator Snapper.

This is a very rare turtle in this neighborhood. I have one in my collection which comes from Cottonwood Point, Pemiscott County, Mo. The fishermen bring them to the market as a curiosity, but they are not valued as much as the common snapper.

FAMILY KINOSTERNIDAE.

GENUS AROMOCHELYS. (Gray.)

36. *Aromochelys Odorata* (Bosc.) Musk Turtle or Stink Pot.

It is essentially an aquatic turtle, found in ponds and deep creeks. Particularly in spring the old males smell strong after musk. It is a small turtle in size, and with the first warm day they come out of their winter quarters to enjoy the sun.

FAMILY TESTUDINIDAE.

GENUS CHRYSEMYS. (Gray.)

37. *Chrysemys Troositi.* (Holb.) The Yellow Bellied Terrapin.

Very little is known of this turtle, as it is only caught by seining in the deep water of the Mississippi river.

38. *Chrysemys Elegans.* (P. Max de Wied.) The Elegant Terrapin.

A common turtle in the Mississippi river and in the lakes and ponds. Found in St. Clair and Madison counties, Ill., and St. Louis County, Mo. They make their appearance in spring as soon as the ice has disappeared.

39. *Chrysemys Belli.* (Gray.) Bell's Turtle.

The common turtle of this neighborhood. This turtle seems to prefer ponds, creeks and sloughs, to a larger body of water. Found in St. Louis County, Mo., and St. Clair and Madison counties, Ills. While hunting in winter time I could see them in a kind of torpid state in the bottom of a creek buried half way in the mud.

GENUS MALACLEMYS. (Gray.)

40. *Malaclemys Pseudo-Geographica.* (Le S.) Le Sueur's Map Turtle.

An abundant turtle in the Mississippi and its back waters, both in Missouri and Illinois. They are commonly called the "Saw Back" turtle on account of the toothed ridge along the center of the back.

41. *Malaclemys Geographica.* (Le S.) The Map Turtle.

The same may be said of this turtle as of the preceding one. The old ones take to the deep water of the rivers, and the young ones are found in the creeks and sloughs.

GENUS CISTUDA. (Fleming.)

42. *Cistuda Carolina.* (Linn.) Box Tortoise.

I captured one of this kind near the Missouri Pacific elevator, South St. Louis, Mo. It is doubtful if this turtle lives here, as I am of the opinion that my specimen may have been brought here on freight cars while unloading at the elevator, or escaped from captivity.

43. *Cistuda Carolina Triunguis.* (Agassiz.) Three-toed Box Tortoise.

This is the common box turtle of St. Louis County. I caught one near Cantine, Madison County, Ill., which I sent to the Smithsonian Institute. In regard to color they vary considerably, so much so, that one could take them sometimes for different specimens.

44. *Cistuda Ornata.* (Agassiz.) Painted Box Tortoise.

It is seldom found. So far I found a few specimens in the western part of the city of St. Louis. One at Pilot Knob, Iron County, Mo., and one at Addieville, Washington County, Ill. The one caught at Pilot Knob is now at the Smithsonian Institute, and is an exception to the general description of this kind, owing to it having 13 pairs of marginal shields instead of 12 as is usually the case with these turtles.

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THE GROWTH OF ST. LOUIS CHILDREN.

WILLIAM TOWNSEND PORTER.

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THE GROWTH OF ST. LOUIS CHILDREN.

INTRODUCTION.

In November, 1891, I applied to the Teachers' Committee of the St. Louis Board of Public Schools for permission to make a series of physical measurements of the St. Louis school children. The ends in view were the study of the phenomena of growth, the making of physical standards for each age in the period of school life, and the adjustment of school tasks to the pupil's strength. On the recommendation of Mr. Long, superintendent of the Public Schools, Dr. Hickman and Mr. Walter F. McEntire, at that time chairman of the committee, it was resolved to lay before the Board a statement of the purpose of the measurements and to advise that the permission to make them be granted. This favorable report, for which thanks are due the gentlemen just named, caused the Board to authorize the measurements at its sitting December 8, 1891.

The measurements were collected by what statisticians know as the generalizing method. In the generalizing method, a great number of children is measured once, and the measurements classified according to age. The mean height of the boys or girls at each age is regarded as the height typical of that age. When these typical heights are arranged in order, they show the increase in the height of the type-child during his period of growth and thus express a law of growth. A similar procedure reveals the growth in weight, girth of chest, or any other physical dimension. It is believed that the values got by the generalizing method are the same as would be obtained if a smaller number of children was measured yearly during the growth period. In either case, the accuracy of the result depends on the number of observations at each age, and a high degree of accuracy requires the making of many thousand measurements.

So large an undertaking demands great labor and a considerable expenditure of money. The labor was in the present instance shared by many hands. Most of the measurements were made by the teachers. The measurements of the head and face were made by undergraduates of the St. Louis Medical College. Other members of the same institution were of the greatest service as "special assistants." Messrs. Taussig, Gooden, Soper, Blair, Gross, Schlossstein, Lemen, Loth, Newcomb and Simmons served in this capacity. To their unwearied and long-continued labors and to the support unselfishly given them by their fellow-students the success of the work is chiefly due.

The expense of the investigation was for apparatus, printing and the hire of clerks, and was borne by gentlemen of public spirit in St. Louis. Some of the apparatus was given or loaned free of charge. The Simmons Hardware Company gave callipers and measuring tapes; the Fairbanks Scale Company loaned scales; Mr. F. W. Humphrey loaned a dozen watches; Dr. John Green and Dr. A. E. Ewing gave cards for testing the acuteness of vision, and the Nixon-Jones Printing Company made special rates for printing.

The cordial support of Chancellor Chaplin, Professors H. S. Pritchett, G. Hambach and E. A. Engler of Washington University, the valuable advice of Dr. John B. Shapleigh, and the interest of the Academy of Science of St. Louis are gratefully acknowledged.

The data collected are necessarily of unequal value. Many of the curves constructed from them are highly satisfactory; others present irregularities to be ascribed to an insufficient number of observations at those points. Some investigators have withheld the curves in which such irregularities occur. They have all been printed here, because the wide-spread use of anthropometrical methods in the Public Schools, so much to be desired, seems at present only possible where the measurements are made by the teachers, and it is necessary to know by the examination of the total material of such investigations, what degree of accuracy can be expected.

CHAPTER I.

THE COLLECTION OF THE MEASUREMENTS.

In collecting anthropometrical measurements on a large scale, a systematic working-plan is evidently of much importance. Many things should be borne in mind in making such a plan. The school routine should be disturbed as little as possible; the directions to the measurers should be comprehensive and clear; the apparatus employed should be simple; the measurements should be made during a few months only and in the same season of the year, for the weight of clothing and even the rate of growth differs at different seasons, and measurements collected partly in one season and partly in another cannot be so suitable for comparison as those collected only in the winter or only in the summer; the order in which the schools are visited should be governed by their situation, so that no time may be spent unnecessarily in going and coming; and much care should be taken to collect sufficient data concerning the social condition and the nationality of parents. In short, the construction of a serviceable working-plan for anthropometrical measurements of great numbers of children is a difficult task, and it is to be regretted that the literature is all but barren of suggestions as to the best method of collecting such material. It is hoped for this reason that a description of the methods used in this investigation may be not without value.

The data collected are mentioned in Form A., one of four "forms" employed in this investigation.

Form A.

MALE.

Please Write with Ink.

1. Observer.....
2. School.....
3. Date.....
4. Name of pupil.....
5. Place of birth.....
6. Age at nearest birthday.....

7 In what country was father born .....
8. In what country was mother born.....
9. Occupation of father.....
10. No. of sisters living.....; dead.....
11. No. of brothers living.....; dead.....
12. Residence, No.....Street.

13. Hair { Black. / Dark Brown. / Light Brown. / Red. / Flaxen.

14. Eyes { Dark Brown. / Light Brown. / Blue. / Grey.

15. Height standing.....cm.
16. Height sitting.....cm.
17. Span of arms.....cm.
18. Strength of squeeze, right hand.....lbs.
19. Strength of squeeze, left hand.....lbs.
20. Girth of chest, forced expiration.....cm.
21. Girth of chest, forced inspiration.....cm.
22. Weight.....lbs.
23. Acuteness of vision, right eye.....
24. Acuteness of vision, left eye.....
25. Acuteness of hearing, right ear.....ft..... .....in
26. Acuteness of hearing, left ear.....ft.....in.
27. Length of head.....mm.
28. Width of head.....mm.
29. Height of face.....mm.
30. Width of face.....mm.
31. The height of face from the hair line to the point of chin.....mm.
32. Grade.....

Form B was the same as Form A, except that the paper on which it was printed was green instead of white, the color of Form A, and the word "Male" was replaced by the word "Female."

On Jan. 4, 1892, the first school * in the series to be examined began to set down the answers 1, 2, 3, 4, 13, 14, 32, and its pupils were directed to carry home Form C in order that it might be filled by the parents.

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* Pupils were measured in the following schools: Ames, Blair, Blow, Branch High, Bryan Hill, Carr, Carroll, Carr Lane, Central High, Charless, Chouteau, Clay, Clinton, Crow, Divoll, Douglass, Eliot, Elleardsville, Franklin, Garfield, Hamilton, Hodgen, Humboldt, Irving, Jackson, Jefferson, Laclede, Lafayette, Lincoln, Lowell, Lyon, Madison, Maramec, Mullanphy, O'Fallon, Peabody, Penrose, Pestallozzi, Polytechnic, Pope, Shepard, Shields, Spring Avenue, Stoddard, Webster, New Webster. (The "Branches" of the Clinton and other schools are included.)

Form C.

THE PHYSIQUE OF THE SCHOOL CHILDREN IN ST. LOUIS.

The parents or guardians of school children are requested to fill out the following blank, and to return it to the teacher on the next school day:

4. Name of pupil.....
5. Place of birth.....
6. Age at nearest birthday.....
7. In what country was pupil's father born.....
8. In what country was pupil's mother born.....
9. Occupation of father.....
10. Number of pupil's sisters living.....; dead.....
11. Number of pupil's brothers living.....; dead.....
12. Residence of pupil, No....., ...Street.

On the second day, Form C having been returned, answers 5, 6, 7, 8, 9, 10, 11 and 12 were written. Some ignorant or prejudiced parents refused to answer the questions in Form C and in such cases the answers were obtained as far as possible from the school registers. While the first school was employed in this way on the second day, another school began to answer questions 1, 2, 3, 4 and 32. On the third day, the first school measured the height standing, height sitting and span of arms, while the second school was busy with the second day's work and the third school with the first.

Thus the thirty-two questions were divided into groups, and by the ninth day nine schools were working simultaneously, each on a different group. As soon as one school finished with an apparatus, it was taken to the next school on the list, almost always the nearest in point of distance. An extract from "The Chart of Days" will make this clear.

A PORTION OF "THE CHART OF DAYS."

NAME OF SCHOOL.	SPECIAL ASSISTANT.	RECORD: Answers 1, 2, 3, 4, 18, 14, 32. (Color of Hair and Eyes.)	Answers 5, 6, 7, 8, 9, 10, 11, 12.	Height Standing, Height Sitting, Span of Arms.	Strength of Squeeze.	Girth of Chest.	Weight.	Acuteness of Vision.	Acuteness of Hearing.	Head Measurements.
Laclede	Lemen	4*	5	7	8	11	12	13	14	15
Madison and New Madison	Simmons.....	5	6	8	11	12	13	14	15	18
Pestalozzi	Newcomb.....	6	7	11	12	13	14	15	18	19
Carroll	Loth.....	7	8	12	13	14	15	18	19	20
Lafayette and Lafayette Branch..	Taussig.....	8	11	13	14	15	18	19	20	21
Humboldt	Gooden	11	12	14	15	18	19	20	21	22
Lyon	Soper	12	13	15	18	19	20	21	22	25
Shepard...	Blair.....	13	14	18	19	20	21	22	25	26
Meramec	Gross	14	15	19	20	21	22	25	26	27
Blow and Blow Branch	Schlossstein..	15	18	20	21	22	25	26	27	....

The Laclede School began Jan. 4 and finished Jan. 15, the Madison School began Jan. 5 and finished Jan. 18, and so through the list.

Nearly nine thousand pupils were examined each school-day after the ninth, and each day saw the returns of nearly a thousand pupils completed. The collection of material was finished in fifty-four school-days, beginning Jan. 4 and ending March 18. During this period of about 11 weeks, 18059 girls and 16295 boys were examined † and nearly one million data collected, about five hundred thousand of which were measurements, a result which would hardly have been possible without the strenuous exertions of my assistants.

One of the Special Assistants mentioned in the Chart of Days was assigned to each school under investigation. It was his duty to visit the school every day for the purpose of giving any explanation which might be necessary. He was

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* This and the following numbers are the days of the month on which the respective groups of measurements were made.

† Owing to absentees, the number of returns of any one measurement, e. g., height, was less than the number here given.

charged also to see that his school finished its allotted daily task and dispatched at the close of the session the apparatus in its hands to the next school on the list. In addition to these nine Special Assistants, thirty Head Measurers were employed. The Head Measurers were divided into five sections named after the days of the school week from Monday to Friday. Each section went on its own day to the school whose turn it was to have heads and faces measured. The remaining measurements were made by the teachers.

Not even the industry of these many assistants would have accomplished the task in the required time had there not been an abundance of apparatus. Of measuring-rods, measuring-tapes for the chest, double sets of Snellen-Green test letters, spectacle blinders, watches and callipers, there were a dozen each, and five dynamometers and six small platform-scales were also in constant use. Twelve school rooms could thus often work at the same time, and a great many children were measured in a few hours.

The following printed instructions were given to every measurer.

Form D.

INSTRUCTIONS TO OBSERVERS.

Four printed forms are furnished. These are:

Form A. Male (white paper).
" B. Female (tinted paper).
" C. For parents.
" D. Instructions to observers.

On Monday, January 4th, a sufficient number of these forms will be taken to school A. The same day answers 1, 2, 3, 4, 13, 14 and 32, Form A or B, are written, and each pupil is given Form C to carry home. The next morning form C is returned by the pupils, and answers 5, 6, 7, 8, 9, 10, 11 and 12 are copied on form A or B. The third day the measurements begin, and are carried out according to the following

CALENDAR.

1st day 1, 2, 3, 4, 13, 14, 32.
2d " 5, 6, 7, 8, 9, 10, 11, 12.
3d " 15, 16, 17.
4th " 18, 19.
5th " 20, 21.
6th " 22.
7th " 23, 24.
8th " 25, 26.
9th " 27, 28, 29, 30, 31.

Form C and answers 1 to 12 in forms A and B, require no explanation. The remaining answers are to be sought by the following methods.

Arrange forms A and B in the order in which the pupils sit at their desks, and preserve this arrangement throughout the measurements.

13, 14. Color of Hair and Eyes.

Choose the adjective that most nearly indicates the color; cross out the rest with pen and ink.

15. Height Standing.

1. All the pupils unlace their shoes.

2. The teacher places the measuring rod against the cloak-room door casing, the projections on the rod serving to keep it parallel with the casing, and presumably perpendicular to the floor.

3. The pupil in the first seat comes forward, removes his shoes, stands on a folded newspaper upon which the rod also rests, his heels, body and head touching the door casing, the mouth closed and the chin somewhat depressed. Hair worn in a high knot must be let down.

4. Lower the sliding arm until the edge touches the crown of the pupil's head, and dictate the reading to a pupil assistant, who writes it opposite "15. Height standing." Meanwhile, the second pupil gets ready. [The rods are divided in centimetres and half centimetres; it will be easy to read to quarter centimetres. The dictation should be in the decimal system; thus: "One hundred fifteen, seventy-five (written 115.75), not one hundred fifteen and three quarters.]

5. The first pupil steps to one side, puts on his shoes, returns to his seat, and there laces his shoes. The second pupil removes his shoes and steps on the newspaper. The third pupil comes forward.

16. Height Sitting.

Place an armless wooden chair with a flat seat sideways against the door casing. The measuring rod is held perpendicularly on the seat, the projections on the rod touching if possible the casing. Pupils come forward as before.

Take care: 1, that the lower part of the spinal column touches the rod; 2, that the mouth is closed and the chin somewhat depressed; 3, that hair worn in a knot on the back of the head does not introduce an error. Measure, and dictate the reading.

17. Span of Arms.

1. Draw on the wall a chalk mark parallel with the floor and as high as the chin of a pupil of average height.

2. Hold the measuring rod parallel to the line and as high as the neck of the pupil to be measured.

3. The pupil touches one end with the middle finger of one hand and stretches along the rod as far as he can reach; chin up, heels together, body as close as possible to the rod.

4. Dictate the reading.

[In this and all other measurements the place of the pupil measured should be instantly taken by another.]

18, 19. Strength of Squeeze.

1. Depress the trigger of the dynamometer until the point of the indicator is exactly over the zero line of the scale.

2. The pupil grasps the oval ring in the right hand and squeezes his best.

3. Read the outer scale (graduated from 0 to 160) to pounds * as exactly as possible. Write the number after "18. Strength of Squeeze, right hand."

4. Reset the instrument, and test left hand. [Please do not touch the indicator. Always use the trigger.]

20, 21. Girth of Chest.

1. Take four pupils into the cloak room. They remove clothing over chest down to the garment next the skin. The measurements are made *on a level* with the nipples, and are dictated in centimetres and decimal fractions of a centimetre to a pupil assistant, who writes them opposite 20 and 21.

2. "Forced expiration." Pupil breathes out, makes chest as small as possible, inclines head forwards, draws shoulders slightly together.

3. "Forced inspiration." Shoulders back, head raised, deepest possible inspiration.

[Some children will require to be shown how to do this. As fast as a pupil is measured, dresses and returns to his seat, another pupil enters the cloak room to take his place, and strips for measurement.]

22. Weight.

The upper figures on the beam and the smaller of the two numbers on the iron weights are used with the scale pan. Pay no attention to them. The lower figures on the beam read from 1 to 45 pounds. Place the pupil's approximate weight on the counterpoise at the end of the beam; move the poise along the latter until the scale balances. Add the larger number on the hanging weight to the number marked on the lower scale by the poise. The sum is the pupil's weight.

23, 24. Acuteness of Vision.

It is necessary to make these tests between 10:30 a. m., or better 11 a. m., and 3 p. m., as at other hours the winter light is insufficient.

A pupil must not see the card before the moment for his test has come. Nor can the pupils who have been tested be allowed to communicate with those yet to be tested. Otherwise the letters will be committed to memory and the test spoiled.

1. Hang the test card on the wall opposite the windows, in a good light, and level with the pupil's eyes. Turn down the middle leaf of the card, so that only one set of test letters is visible.

2. Stand the pupil with toes touching a chalk mark 16 feet 5 inches from the card, and cover the left eye with the blinder furnished for that purpose. The head must be held straight, so that the child cannot see the test letters with the blinded eye.

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* wo dynamometers were graduated metrically.

3. The child reads the test letters beginning with the largest; the smallest letter which can be read indicates the "acuteness of vision" at 16 feet 5 inches (5 metres). Mark the arabic figure under this letter opposite "Acuteness of Vision, right eye."

4. Change the blinder to the right eye.

5. Turn up the middle leaf of the test card so as to expose the second set of test letters.

6. Test the acuteness of vision of the left eye in a similar manner.

25, 26. Acuteness of Hearing.

The hearing tests are to be made in the cloak-room with the doors closed. Their success depends primarily on the absence of all noise from the adjacent class-rooms and halls.

1. The pupil is seated with the right ear towards the observer.

2. An assistant closes the pupil's left ear by pressing the *tragus* (the little cartilage in front of the external opening) inwards with her thumb while with the fingers of the same hand she closes the eyelids with a handkerchief. With the other hand the assistant holds the end of the brass ring of the tape measure against the head just beneath the ear, grasping the ring between thumb and forefinger and keeping the hand entirely below the auditory opening.

3. The observer stands directly opposite the ear and 11 feet from it, holding the tape parallel with the floor. The watch is held by the chain ring against the median line of the observer's body, just above and not touching the tape. The face of the watch is towards the pupil.

4. The observer charges the pupil to say "now" when he hears the watch tick, and advances the watch until the pupil replies. The watch is now withdrawn and again advanced until the pupil replies. Marking this point on the tape measure between finger and thumb, the observer puts the watch behind her back, and asks "Do you hear now?" If the pupil replies "No," the watch is returned to the former position and the inquiry repeated. If the watch is again heard at this distanee the test is satisfactory; if not, it should be repeated. Write the distance at which the watch is heard in feet and inches opposite "Acuteness of Hearing, right ear."

5. Turn the pupil around (180°) and test the left ear in a similar manner.

The wilfulness of some children will make the accuracy of their tests doubtful. In such cases write an interrogation mark after the figures secured.

27, 28, 29, 30. Head Measurements.

The teacher carries the blanks arranged in the order in which the pupils sit in her room, a pen, and a centimetre rule. The medical assistant makes a measurement, places the callipers on the rule which the teacher holds, and reads the number of centimetres and millimetres. The teacher writes these numbers while the assistant makes the next measurement.

Instructions for Medical Assistants.

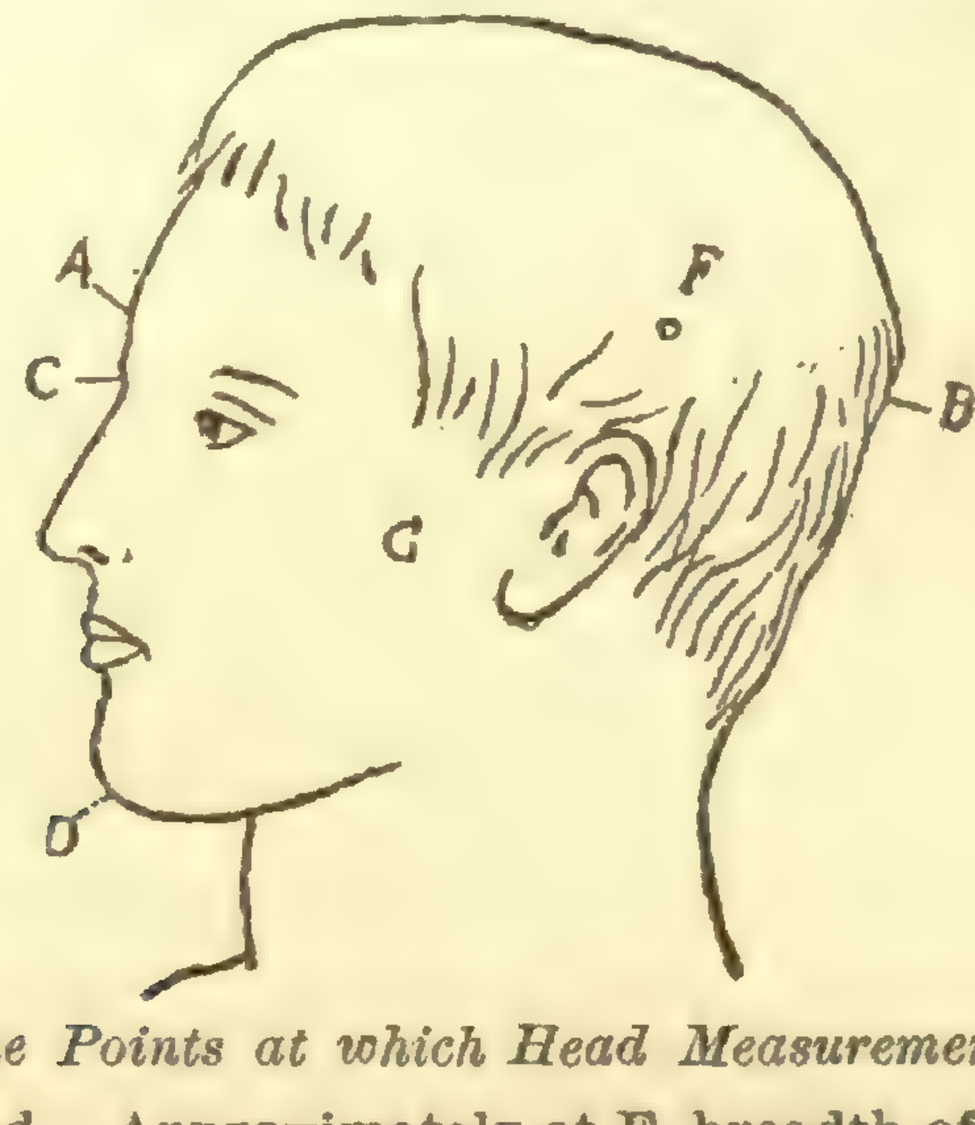
Measurements must be read to millimetres.

1. *Length of head.* — Place one point of the callipers on the most prominent point of the forehead, between the eyebrows. Bring the other point of the callipers down to the posterior part of the head and move it along the middle line until the greatest length of the head is found. (A, B.)

2. *Breadth of head.* — Take the greatest breadth of the head between the ears wherever it is found. Hold the callipers horizontally and perfectly symmetrically, approximately at F.

3. *Height of face.*— Put one point of the callipers in the deepest depression on the nose between the eyes (C)— then press the other point against the chin and find that point at D where the chin turns backwards. Ask the person to press his teeth together.

4. *Breadth of face.*— This is the greatest breadth between the narrow, bony ridges felt in front of the ears. The ridges run from the cheek bones to the ears. Hold the callipers horizontally and symmetrically, approximately at G.



Position of the Points at which Head Measurements are Taken.

A-B, length of head. Approximately at F, breadth of head. C-D, Height of face. Approximately at G, breadth of face.*

5. *Hair line.* — This is the height of face from the point of the chin to the point where the hair begins to grow above the forehead.

Further information, if desired, may be had by addressing the Physiological Laboratory of Washington University, 625 Clark avenue.†

W. Townsend Porter.

Approved Jan. 4th, 1891.

E. H. Long,
Superintendent.

Some changes were made in the above instructions during the course of the investigations. The tests of acuteness of hearing were found impracticable because of the unavoidable noise in the schools and were given up after about seven thousand pupils had been tested. It was noticed that the number possessing less than the normal acuteness of hearing was very large, and more than one pupil was found who had been punished for inattention, the result of an unsuspected

* I am indebted to Dr. Franz Boas for this figure.

† Since removed to 1806 Locust street. Dr. Porter's present address is Harvard Medical School, Boston, Mass.

deafness. Although the returns did not seem sufficiently trustworthy for statistical treatment, they justified the statement that not a little deafness exists unknown to both teacher and parents. This hidden infirmity deprives the pupil of much of the benefit of class-room instruction.

The measurement of the girth of chest over the garment next the skin was also modified after several thousand boys and girls had been measured, and the boys were made to remove coats and vests while the girls were measured over the indoor dress. The few girls who wore stays laid them aside.

CHAPTER II.

THE STATISTICAL METHODS EMPLOYED.

All measurements are accompanied by unavoidable errors. Thus the attempt to measure the height of a man is influenced by the accuracy with which the measuring apparatus is constructed, the care with which it is used, the position of the man's head on the vertebral column, the thickness of the intervertebral disks and a multitude of other factors. Some of these influences would make the observed height greater than the true height, others would make it less. The one group tends to counteract or compensate the other, and the result of their conflict is the measurement actually observed. The observed height therefore is never, except by chance, the real height, but deviates from it in one or the other direction — is now above and now below the truth — as one or the other group of influences gets the upper hand. The greater the number of influences, the more perfectly does compensation take place and the more nearly does the observed result approach the truth. But the truth itself can never be known, for only when the number of influences is infinite, can the probability of perfect compensation between them rise to a certainty. That which we call true is merely the probable truth and is worthy of confidence in exact proportion to its numerical probability.

The influences which affect a measurement are of two sorts, the one accidental and varying, such as, taking the measurement of height for an example, the degree of inclination of the head to the axis of the body, the placing of the measuring-rod and the like, the other constant and unvarying, such as an inaccuracy in the construction of the measuring-rod or a persistent bias in the mind of the observer. In both classes, the degree of compensation varies with the number of influences, for even a constant cause, although not accidental in its nature and found always on one side of the mean, may be compensated by another constant cause on the opposite side of the

mean. The accidental or varying influences, however, are much more numerous than the constant or unvarying, and thus compensation is in their case much more complete. Constant, unvarying influences are therefore more deceptive than varying, accidental influences.

In practice, the influences determining the result of a single measurement elude all attempts at calculation, and the extent to which the result of a single observation approximates the truth cannot be told. But if many measurements are made of the same thing, for example the height of a man, the individual measurements arrange themselves on either side of the true height. If only accidental influences have been at work in each individual measurement in the series, the distribution of the observed heights on either side of the real height would, if the number of observations were infinite, be symmetrical. Thus the true height would at once appear, and the probability or degree of deviation of any single measurement would also be visible. Even with finite numbers a probability so great as to amount to a practical certainty can be secured. If 2,000 measurements of the same physical dimension, e. g. the height of an individual, are made carefully, the total number of observations will be distributed nearly as follows: —

TABLE No. 1.

THE DISTRIBUTION OF 2,000 MEASUREMENTS OF THE SAME QUANTITY WHEN THE DEVIATION OF THE INDIVIDUAL OBSERVATIONS FROM THE TRUE VALUE OF THE MEASURED QUANTITY IS DUE TO PURELY ACCIDENTAL CAUSES.*

d = the Probable Deviation.	Number of Observations.
Greater than $+ 5.0\ d$	1
$+ 4.5\ d$ to $+ 5.0\ d$	1
$+ 4.0\ d$ " $+ 4.5\ d$	5
$+ 3.5\ d$ " $+ 4.0\ d$	11
$+ 3.0\ d$ " $+ 3.5\ d$	25
$+ 2.5\ d$ " $+ 3.0\ d$	49
$+ 2.0\ d$ " $+ 2.5\ d$	85
$+ 1.5\ d$ " $+ 2.0\ d$	135
$+ 1.0\ d$ " $+ 1.5\ d$	188
$+ 0.5\ d$ " $+ 1.0\ d$	236
$\pm$ .0 " $+ 0.5\ d$	264
$- 0.5\ d$ " $\pm$ .0	264
$- 1.0\ d$ " $- 0.5\ d$	236
$- 1.5\ d$ " $- 1.0\ d$	188
$- 2.0\ d$ " $- 1.5\ d$	135
$- 2.5\ d$ " $- 2.0\ d$	85
$- 3.0\ d$ " $- 2.5\ d$	49
$- 3.5\ d$ " $- 3.0\ d$	25
$- 4.0\ d$ " $- 3.5\ d$	11
$- 4.5\ d$ " $- 4.0\ d$	5
$- 5.0\ d$ " $- 4.5\ d$	1
Greater than $- 5.0\ d$	1

This result is quite independent of the nature of the thing measured, provided that no unvarying influences are at work.

An examination of Table No. 1 shows (1) that the distribution of the observations is symmetrical about a median point, in other words that equal deviations to one and the other side of this point are equally probable; (2) that half the whole number of observations fall within $\pm$ 1.0 d of the most probable value, indicating that a small deviation is more probable than a large one; and (3) that there is a limit beyond which no deviation occurs. Such are the peculiarities of a series of observations in which the deviations from the true value are due to purely accidental causes. It is evident that the most probable value of the true measurement is typical of the whole series, and that the degree of probability of any devia-

* After Thoma: Untersuchungen über die Grösse der anatomischen Bestandtheile des menschlichen Körpers im gesunden und kranken Zustande. Leipzig, 1882. Page 28.

tion from the type is easily calculated; for example in the series of Table No. 1, the chances are even that any deviation will fall between +1.0 *d* and—1.0 *d*, for it has been seen that half the whole number of observations fall within these limits.

Quetelet demonstrated that the method of grouping related measurements could be used not only for showing the most probable height of one individual but also for showing the most probable or typical height, i. e., that most often found, of a number of individuals. The Belgian Astronomer Royal pointed out that the series obtained by measuring a number of individuals of the same type, e. g., men of the same nationality, was characterized by the peculiarities that distinguish a series in which the deviations from the typical or most probable value are due to accidental causes. The truth of this statement is obvious when the two are compared.

TABLE No. 2.*

HEIGHTS OF UNITED STATES RECRUITS.

Height at Intervals of One Inch.	Number of Recruits.
Between 78 and 79 inches	2
" 77 " 78 "	6
" 76 " 77 "	9
" 75 " 76 "	42
" 74 " 75 "	118
" 73 " 74 "	343
" 72 " 73 "	680
" 71 " 72 "	1485
" 70 " 71 "	2075
" 69 " 70 "	3133
" 68 " 69 "	3631
" 67 " 68 "	4054
" 66 " 67 "	3475
" 65 " 66 "	3019
" 64 " 65 "	1947
" 63 " 64 "	1237
" 62 " 63 "	526
" 61 " 62 "	50
" 60 " 61 "	15
" 59 " 60 "	10
" 58 " 59 "	6
" 57 " 58 "	7
" 56 " 57 "	3
" 55 " 56 "	1
" 55 and less	4
	Total...25878

* E. B. Elliott's table in Medical Statistics of the Provost-Marshal-General's Bureau, by J. H. Baxter, 1875, Vol. I. Introduction, page lxxx.

If the individual heights of a group of adults are found to be approximations of a middle, typical height, it would seem that the heights of children of the same sex, age and class must show a similar relation to a type; and this inference is justified by observation.

TABLE No. 3.

OBSERVED DISTRIBUTION OF THE HEIGHTS OF 2192 ST. LOUIS SCHOOL GIRLS, AGED 8.

Heights at Intervals of 2 Centimetres.	Number of Observations.
141 and 142 cm.	1
139 " 140 "	
137 " 138 "	1
135 " 136 "	5
133 " 134 "	10
131 " 132 "	21
129 " 130 "	28
127 " 128 "	79
125 " 126 "	138
123 " 124 "	183
121 " 122 "	243
119 " 120 "	342
117 " 118 "	321
115 " 116 "	297
113 " 114 "	222
111 " 112 "	137
109 " 110 "	84
107 " 108 "	42
105 " 106 "	27
103 " 104 "	8
101 " 102 "	2
99 " 100 "	1
Total	2192

The characteristics of a series in which the individual observations are accidental deviations from a typical middle value are established by methods which have long been used by astronomers and mathematicians. These methods seek to determine (1) the middle or typical value and (2) the way in which the individual observations are dispersed on either side of this value. Some statisticians take the average to be the nearest approach to the typical value, others prefer the mean, i. e., median value.* It will be necessary to consider at some length the relative value of average and mean in anthropometrical studies of the growth of children, but for the present a

* Throughout this work the word MEAN is used as the synonym of MEDIAN VALUE, and not in the sense of ARITHMETICAL MEAN, which is called here the AVERAGE. The MIDDLE VALUE will be employed as meaning either Median or Average value.

statement of the methods by which the mean and average are secured will suffice.

By AVERAGE (A) is meant the quotient obtained by dividing the sum (Σa) of the values (a) obtained in the individual measurements by the whole number of measurements (n).

$$A = \frac{\Sigma a}{n} \qquad (1)$$

The calculation of the average height of girls, aged 9, will serve as an example.

TABLE No. 4.

THE CALCULATION OF THE AVERAGE HEIGHT OF ST. LOUIS SCHOOL GIRLS, AGED 9.

Height in Centimetres.	Number of Observations. (n)	Product. (a)	Height in Centimetres.	Number of Observations. (n)	Product. (a)
168	1	168	134	25	3350
167			133	31	4123
166			132	29	3828
165			131	62	8122
164			130	78	10140
163			129	91	11739
162			128	119	15232
161			127	132	16764
160	1	160	126	143	18018
159			125	162	20250
158			124	141	17484
157			123	162	19926
156			122	145	17690
155			121	130	15730
154			120	145	17400
153			119	97	11543
152			118	94	11092
151			117	69	8073
150			116	59	6844
149			115	47	5405
148			114	30	3420
147			113	18	2034
146			112	11	1232
145			111	10	1110
144			110	10	1100
143	1	143	109	5	545
142	2	284	108	1	108
141	3	423	107	5	535
140	2	280	106	3	318
139	3	417	105	1	105
138	9	1242	104	1	104
137	12	1644	103	1	103
136	15	2040	102		
135	14	1890	101		
			100	2	200
			Total.....	$n = 2122$	$\Sigma a = 262358$

$$A = \frac{\Sigma a}{n} = \frac{262358}{2122} = 123.64 \text{ cm.}$$

If the number of observations is very large, the MEAN (MEDIAN value, *M*,) may be found with considerable accuracy by a mere inspection of the series. The mean of such a series is the measurement which most frequently recurs. Thus, the mean height of the recruits of Table No. 2, page 278, is between 67 and 68 inches. The accuracy with which the mean can thus be found depends not only on the number of observations, but also on the size of the units of measurement.

For most purposes it is desirable to know not merely at which inch, centimetre, kilogramme or other unit the greatest number of observations is found, but exactly at what fraction of the unit. Again, the relation between the number of observations and the size of the unit may be such that the largest number of observations at one unit will not fall at the true mean, or line dividing the total number of observations into two equal groups. The method by which the mean can be calculated with exactness will be illustrated by the following example. The mean height of the girls in Table No. 4 is obtained by adding the number of observations from below upwards until the sum cannot be increased by the next number in the column without exceeding half of the total number of observations. Thus 1046 is reached opposite 123 cm.; the next number in the column (141) would make the sum 1187, which is more than the half (1061) of the total number of observations (2122). The mean is, therefore, greater than 123 cm. but less than 125 cm. Its position is found by interpolation. Half of the total number of observations is 1061, which is 15 more than the sum of the observations up to 124 cm.; 15 is 11 per cent. of 141, the observations at 124 cm. Hence, the mean is 124.15 cm.

Neither the mean nor the average can give any information as to the way in which the individual observations in a series are distributed, and it is plain that two series having an identical mean or average may differ greatly in respect of the dispersion of the individuals from the middle value. Thus the two very different series —

4, 5, 6, 14, 15, 16
9, 9, 10, 10, 11, 11

have the same average (10). The best measure of the degree of dispersion or deviation of the individual members of a series from their common mean or average is that afforded by the Probable Deviation. The probable deviation is that deviation from the middle value, which, in a large series of observations, is as often exceeded as attained (Lexis). In other words, half of the whole number of observations fall short of the probable deviation, while the other half exceed it. A deviation which exceeds is as probable as one that does not reach this value. The probable deviation can be calculated with the formula —

$$d = \pm 0.6745 \sqrt{\frac{\Sigma \delta^2}{n-1}} \qquad (2)$$

In this formula:

d = the probable deviation.
$\Sigma\delta^2$ = the sum of the squares of the individual deviations from the mean or average.
n = the number of observations in the series.

In the place of this formula, in which the calculation of $\Sigma\delta^2$ requires much labor when the number of observations is great, a simpler formula may be safely used in getting the deviation in a large series.

$$d = \pm 0.8453 \frac{\Sigma \delta}{n} \qquad (3)$$

The formula says that all the individual deviations from the mean or average of a series must be added together without regard to whether they are plus or minus and divided by the total number of observations. The working of the formula will be illustrated by finding the probable deviation from the average height of girls aged 8.

TABLE No. 5.

THE CALCULATION OF THE PROBABLE DEVIATION (d) FROM THE AVERAGE HEIGHT (118.36 CM.) of 2193 GIRLS, AGED 8.

Height at Intervals of 2 Centimetres.	Σ	δ	$\Sigma\,\delta$
141 and 142 Cm.	1	23.64	23.64
139 " 140 "			
137 " 138 "	1	19.64	19.64
135 " 136 "	5	17.64	88.20
133 " 134 "	10	15.64	156.40
131 " 132 "	21	13.64	286.44
129 " 130 "	28	11.64	325.92
127 " 128 "	79	9.64	761.56
125 " 126 "	138	7.64	1054.32
123 " 124 "	183	5.64	1032.12
121 " 122 "	243	3.64	884.52
119 " 120 "	342	1.64	560.88
117 " 118 "	321	0.36	115.56
115 " 116 "	297	2.36	700.92
113 " 114 "	222	4.36	967.92
111 " 112 "	137	6.36	872.69
109 " 110 "	84	8.36	702.24
107 " 108 "	42	10.36	435.12
105 " 106 "	27	12.36	333.72
103 " 104 "	8	14.36	114.88
101 " 102 "	2	16.36	32.72
99 " 100 "	1	18.36	18.36
Total.....	2192		9487.77

$$d = \pm 0.8453\frac{9487.77}{2192} = \pm 3.698 \text{ Cm.}$$

The distribution of the above series of the heights of girls, aged 8, is therefore characterized by a probable deviation of $\pm$ 3.7 cm.; that is, one against one may be wagered that no girl aged 8 will be taller than 122.06 cm. or shorter than 114.66 cm. If the number of observations falling between $A \pm d$, $A \pm 2d$, $A \pm 3d$..... $A \pm {}^{n}d$ be noted, a complete picture of the individual observations in a series will be obtained. This observed distribution may then be compared directly with the distribution of the observations in an hypothetical series constructed according to the calculus of probabilities. The observed and the theoretical series should correspond, if the causes of deviation are purely accidental. It has already been said that such a comparison must be made before it can be known whether the observations in any series can be treated by the methods of the theory of probabilities. It is however not necessary to compare more than one of a num-

ber of series in which the distribution follows a common type. It will suffice for our purposes therefore to compare the distribution of the 2192 heights in Table No. 3, page 279, with the distribution of an equal number according to the calculus of probabilities. The method by which this is done permits the construction of a curve from the observations actually made which shall be the probable form of a curve representing the distribution of the entire class from which the observations have been drawn.

The number of observation (Z) which should be included between the average (A) and any deviation from the average, in other words any multiple (m) of the probable deviation (d), is obtained from the equation.*

$$P = \frac{2}{\sqrt{\pi}} \int_0^t e^{-t^2} dt \qquad (4)$$

The labor of calculating deviations with the aid of this equation is avoided by the use of such tables as Stieda's, reproduced below.

TABLE No. 6.

STIEDA'S TABLE FOR CALCULATING THE NUMBER OF OBSERVATIONS AT ANY DISTANCE FROM THE MEAN OR AVERAGE WITHIN THE LIMITS: M+ $5d$ AND M —$5d$.

p	Percent.	p	Percent.
0.1	5.4	1.8	77.5
0.2	10.7	1.9	80.0
0.3	16.0	2.0	82.3
0.4	21.3	2.1	84.3
0.5	26.4	2.2	86.2
0.6	31.4	2.3	87.9
0.7	36.3	2.4	89.5
0.8	41.1	2.5	90.8
0.9	45.6	2.6	92.1
1.0	50.0	2.7	93.1
1.1	54.2	2.8	94.1
1.2	58.2	2.9	95.0
1.3	61.9	3.0	95.7
1.4	65.5	3.5	98.2
1.5	68.8	4.0	99.3
1.6	71.9	4.5	99.8
1.7	74.8	5.0	99.93

* Kramp. L'Analyse des réfractions astronomiques.

If p is allowed to represent one of the figures in the first column and A the average of all the measurements in a series, the figures opposite p in the second column will give the per cent. of individual measurements lying within the limits:

$$\text{A} + p \,.\, d \text{ and A} - p \,.\, d$$

Suppose for example it were required to know how many of a series of 2192 girls aged 8 were of a height between the average (118.36 cm.) and a deviation of $\pm$ 1.5 d (1.5. 3.7 cm. = 5.55 cm.), i. e. between 118.36 cm. + 5.55 cm. = 123.91 cm. and 118.36 cm. — 5.55 cm. = 112.81 cm. The number in the table opposite 1.5 is 68.8, which says that 68.8 per cent. of the 2192, or 1508, should fall within the limits stated. Then half this number must fall between A and A + 1.5 d (118.36 cm. and 123.91 cm.). In a similar manner it will be found that 50 per cent. of the whole number, or 1096, should fall within the limits A $\pm$ d (118.36 cm. + 3.7 cm. = 122.06 cm. and 118.36 cm. — 3.7 cm. = 116.51 cm.), and 25 per cent. between A and A + d (118.36 cm. and 122.06 cm.). Thus may be calculated the number of observations which should occur at any deviation from the average. The theoretical and observed distribution of 2192 girls, aged 8, is compared in Table No. 7.

TABLE No. 7.

THE THEORETICAL AND THE OBSERVED DISTRIBUTION OF THE HEIGHTS OF 2192 GIRLS, AGED 8.

Probable Deviation *d*.	Heights at Intervals of $\pm$ 0.5*d*.	Theoretical Distribution.	Observed Distribution.
+ 5.0 *d*	136.86 Cm.	2	2
+ 4.5 "	135.01 "	6	8
+ 4.0 "	133.26 "	12	18
+ 3.5 "	131.31 "	27	27
+ 3.0 "	129.46 "	54	57
+ 2.5 "	127.61 "	93	104
+ 2.0 "	125.76 "	148	150
+ 1.5 "	123.91 "	206	209
+ 1.0 "	122.06 "	259	286
+ 0.5 "	120.21 "	289	300
0.0 "	118.36 "		
— 0.5 "	116.51 "	289	272
— 1.0 "	114.66 "	259	275
— 1.5 "	112.81 "	206	196
— 2.0 "	110.96 "	148	126
— 2.5 "	109.11 "	93	80
— 3.0 "	107.26 "	54	40
— 3.5 "	105.41 "	27	26
— 4.0 "	103.56 "	12	12
— 4.5 "	101.71 "	6	3
— 5.0 "	99.86 "	2	2
	Total.....	2192	2192

The curves in Plate I * give a graphic representation of the figures in Table No. 7. A glance at these curves shows that there is a close agreement between them, indicating that the individual observations out of which they are constructed are symmetrically grouped about a middle value typical of the whole, and proving that the material with which we have to deal satisfies the requirements of theory.

The method of showing distribution just described is not the only method used for this purpose. Francis Galton † determines the actual distribution of the observations in a series at intervals of 5 or 10 per cent. from the median or 50 "percentile grade." The calculation of the median value (mean) or 50 percentile grade has already been described: that for the 5, 10, 20 and other percentile grades is similar in

* The plates are placed after the index at the end of the number.

† Natural Inheritance. London, 1889.

principle. The percentile grades of the heights of girls, aged 9, are as follows: —

TABLE No. 8.

THE PERCENTILE DISTRIBUTION OF THE HEIGHTS OF GIRLS, AGED 9.

Percentile Grades.	Number of Observations.	Heights.
95	2015.9	133.42 Cm.
90	1909.8	130.97 "
80	1697.6	128.62 "
75	1591.5	127.58 "
70	1485.4	126.54 "
60	1273.2	125.53 "
50	1061.0	124.11 "
40	848.8	122.76 "
30	636.6	121.21 "
25	530.5	120.90 "
20	424.4	119.59 "
10	212.2	117.12 "
5	106.1	115.17 "
Total.....	2122	

The Probable Error of the Average can be determined by means of the formula

$$E = \pm \frac{d}{\sqrt{n}} \qquad (5)^*$$

where E = the probable error of the average,
d = the probable deviation of an individual from the average,
n = the number of observations in the series.

Substituting the values determined for the heights of girls, aged 9, we have —

$$E = \pm \frac{3.698}{\sqrt{2122}} = \pm 0.079 \text{ cm.}$$

The values of E are given in Table No. 9.

* Formulas (1), (2), (3) and (5) and Table No. 6 are taken from L. Stieda's admirable article: Ueber die Anwendung der Wahrscheinlichkeitsrechnung in der anthropologischen Statistik. Archiv. für Anthropologie, Bd. xiv., 1882, p. 167-182.

TABLE No. 9.

THE PROBABLE ERROR OF THE AVERAGE: $E = \pm \frac{d}{\sqrt{n}}$, where e = Probable Error, d = Probable Deviation, n = Number of Observations.

Dimensions.	Sex.	Unit of Measurement.	Age at Nearest Birthday, and Probable Error.															
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Weight, in Indoor Dress.	Boys.	Kilogramme	± **0.054**	± **0.039**	± **0.042**	± **0.045**	± **0.049**	± **0.062**	± **0.061**	± **0.110**	± **0.148**	± **0.227**	± **0.431**	± **0.521**	±	±	±	±
	Girls.		0.051	0.045	0.042	0.049	0.052	0.070	0.081	0.115	0.142	0.154	0.207	0.244	0.289	0.332	0.565	
Height Standing, Without Shoes.	Boys.	Centimetre..	**0.128**	**0.084**	**0.082**	**0.080**	**0.087**	**0.099**	**0.116**	**0.140**	**0.183**	**0.286**	**0.427**	**0.592**	**0.924**			
	Girls.		0.123	0.089	0.079	0.083	0.089	0.106	0.098	0.150	0.156	0.151	0.197	0.241	0.265	0.438	0.353	0.651
Height Sitting.....	Boys.	Centimetre..	**0.105**	**0.061**	**0.048**	**0.049**	**0.053**	**0.060**	**0.067**	**0.076**	**0.103**	**0.161**	**0.250**	**0.427**	**0.536**			
	Girls.		0.132	0.053	0.044	0.046	0.049	0.057	0.063	0.078	0.095	0.098	0.116	0.153	0.133	0.198	0.230	0.290
Span of Arms.....	Boys.	Centimetre..	**0.144**	**0.096**	**0.088**	**0.089**	**0.103**	**0.113**	**0.112**	**0.159**	**0.197**	**0.321**	**0.574**	**0.581**	**0.761**			
	Girls.		0.140	0.107	0.092	0.092	0.104	0.116	0.109	0.150	0.160	0.176	0.217	0.285	0.334	0.517	0.474	0.712
Girth of Chest, Inspiration.	Boys.	Centimetre..	**0.083**	**0.057**	**0.051**	**0.053**	**0.059**	**0.065**	**0.072**	**0.089**	**0.116**	**0.172**	**0.305**	**0.332**	**0.551**			
	Girls.		0.087	0.061	0.053	0.056	0.060	0.072	0.078	0.097	0.113	0.137	0.152	0.217	0.243	0.340	0.331	0.482
Girth of Chest, Expiration.	Boys.	Centimetre..	**0.083**	**0.057**	**0.052**	**0.056**	**0.063**	**0.061**	**0.076**	**0.088**	**0.119**	**0.165**	**0.281**	**0.374**	**0.504**			
	Girls.		0.094	0.062	0.053	0.058	0.062	0.078	0.083	0.098	0.115	0.148	0.175	0.248	0.265	0.420	0.347	0.560
Strength of Squeeze, Right Hand.....	Boys.	Kilogramme	**0.056**	**0.039**	**0.045**	**0.055**	**0.061**	**0.068**	**0.082**	**0.126**	**0.143**	**0.244**	**0.414**	**0.458**				
	Girls.		0.053	0.043	0.043	0.049	0.053	0.060	0.072	0.093	0.133	0.147	0.200					
Strength of Squeeze, Left Hand.....	Boys.	Kilogramme	**0.057**	**0.044**	**0.048**	**0.059**	**0.059**	**0.067**	**0.080**	**0.103**	**0.134**	**0.243**	**0.438**	**0.639**				
	Girls.		0.056	0.042	0.046	0.049	0.053	0.059	0.076	0.094	0.127	0.154	0.207	0.264				
Length of Head.....	Boys.	Millimetre..	**0.171**	**0.118**	**0.106**	**0.109**	**0.094**	**0.129**	**0.115**	**0.131**	**0.182**	**0.208**	**0.355**	**0.575**	**0.717**			
	Girls.		0.170	0.108	0.092	0.101	0.102	0.119	0.114	0.132	0.143	0.180	0.256	0.275	0.252	0.466	0.433	
Width of Head.....	Boys.	Millimetre..	**0.118**	**0.090**	**0.082**	**0.084**	**0.090**	**0.095**	**0.092**	**0.114**	**0.129**	**0.186**	**0.249**	**0.486**	**0.685**			
	Girls.		0.154	0.099	0.082	0.083	0.093	0.097	0.105	0.115	0.130	0.150	0.210	0.242	0.300	0.466	0.426	
Root of Nose to Point of Chin.	Boys.	Millimetre..	**0.207**	**0.120**	**0.103**	**0.107**	**0.110**	**0.127**	**0.132**	**0.160**	**0.174**	**0.238**	**0.346**	**0.744**	**0.883**			
	Girls.		0.194	0.115	0.099	0.103	0.109	0.116	0.129	0.133	0.156	0.192	0.245	0.345	0.297	0.421	0.469	0.627
Width of Face.....	Boys.	Millimetre..	**0.172**	**0.101**	**0.090**	**0.101**	**0.092**	**0.108**	**0.113**	**0.122**	**0.153**	**0.196**	**0.360**	**0.527**	**0.718**			
	Girls.		0.174	0.101	0.087	0.092	0.127	0.107	0.109	0.127	0.135	0.157	0.201	0.275	0.265	0.420	0.419	0.528
Hair Line to Point of Chin.	Boys.	Millimetre..	**0.209**	**0.159**	**0.122**	**0.127**	**0.127**	**0.143**	**0.137**	**0.173**	**0.236**	**0.292**	**6.425**	**0.853**	**0.139**			
	Girls.		0.238	0.137	0.119	0.121	0.131	0.143	0.148	0.173	0.193	0.211	0.286	0.437	0.520	0.749	0.560	0.786

The mean or average of the observations at any age in the period of growth is typical of the child at that age, and a comparison of the means at different ages will reveal the law of growth of the type. Again, the mean of the observations at any deviation from the mean of the whole number, for example the height at a deviation of $+ d$ from the mean, or, if Galton's method is employed, the height at any percentile grade, is the type of those who stand at a certain degree of deviation from the type of the whole number. Thus types of tall and short, light and heavy children are secured. The types of the same degree of deviation from the mean at all ages are as comparable as the type of the whole number of observations, and reveal the growth of the typically tall and short, light and heavy children; but the comparison is less secure the greater the deviation from the mean, for the probable error is inversely as the square of the number of observations, and the number of observations rapidly diminishes on either side of the mean.

The methods described in this chapter have been employed in the present investigation. For every entire series here presented, the mean and the average, the probable deviation and the probable error, and the 5, 10, 20, 25, 30, 40, 50, 60, 70, 75, 80, 90 and 95 percentile grades have been calculated. The 25 and 75 percentile grades were obtained by dividing by 2 the sums of the 20 and 30, and the 70 and 80 percentile grades respectively.

CHAPTER III.

TRUSTWORTHINESS OF THE MATERIAL; ITS LIMITATIONS. COMPARISON OF MEDIAN AND AVERAGE VALUES.

The question first to be decided in the discussion of an anthropometrical series is whether the individual observations are so related one to another that they constitute accidental deviations from a middle value. The method of answering this question by comparing the series of observations with a series constructed according to the theory of probabilities has already been described, and it has been stated incidentally that the heights of St. Louis girls aged 8 agreed with the theoretical series in their distribution. Where such an agreement exists, the individual observations are to be regarded as approximations of a middle value which is the type of the series. It is not necessary to make this comparison at more than one age, or in more than one dimension, for it is known that if one series in a group like that with which we have to deal shows this agreement the other series will be found to do the same. In the present case, additional evidence of the correspondence between observation and theory could be furnished, were it required, by Table No. 10, containing the probable deviation

TABLE No. 10.

THE PROBABLE DEVIATION (d) FROM THE AVERAGE: $d = \pm\ 0.8453.\ \frac{\Sigma\,\delta}{n}$, where

δ = Deviation from Average.
$\Sigma\delta$ = Sum of Individual Deviations.
n = Total Number of Observations.

Dimensions.	Sex.	Unit of Measurement.	Age at Nearest Birthday and Probable Deviation.															
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Weight.....	**Boys.**	Kilogramme	± **1.43**	± **1.68**	± **1.96**	± **2.09**	± **2.23**	± **2.60**	± **2.46**	± **3.88**	± **4.56**	± **5.06**	± **6.16**	± **4.38**	±	±	±	±
	Girls.		1.44	1.88	1.95	2.23	2.31	2.91	3.31	4.22	4.67	4.05	4.24	3.70	3.60	3.76	3.76	
Height Standing....	**Boys.**	Centimetre .	**3.40**	**3.61**	**3.89**	**3.75**	**3.98**	**4.23**	**4.47**	**4.98**	**5.58**	**6.33**	**5.87**	**5.15**	**4.98**			
	Girls.		3.42	3.75	3.70	3.83	4.06	4.48	5.23	5.46	5.15	4.01	4.05	3.45	3.39	4.04	3.08	4.27
Height Sitting.....	**Boys.**	Centimetre .	**2.82**	**2.64**	**2.26**	**2.34**	**2.42**	**2.56**	**2.72**	**2.74**	**3.15**	**3.59**	**3.48**	**3.77**	**2.89**			
	Girls.		2.03	2.19	2.04	2.11	2.19	2.37	2.61	2.87	3.11	2.54	2.36	2.17	1.72	1.82	2.03	1.86
Span of Arms.....	**Boys.**	Centimetre .	**3.85**	**4.16**	**4.18**	**4.25**	**4.70**	**4.84**	**4.57**	**5.71**	**6.03**	**7.15**	**7.89**	**5.03**	**4.31**			
	Girls.		3.87	4.18	4.28	4.18	4.69	4.87	4.51	5.55	5.29	4.58	4.41	4.05	4.28	4.71	4.13	4.33
Girth of Chest, Full Inspiration.	**Boys.**	Centimetre .	**2.28**	**2.39**	**2.34**	**2.42**	**2.63**	**2.70**	**2.86**	**3.13**	**3.51**	**3.84**	**4.37**	**2.95**	**3.07**			
	Girls.		2.38	2.43	2.40	2.50	2.62	2.91	3.14	3.51	3.62	3.53	3.03	3.15	3.11	3.08	2.67	2.73
Girth of Chest Full Expiration.	**Boys.**	Centimetre .	**2.15**	**2.37**	**2.36**	**2.60**	**2.80**	**2.52**	**3.01**	**3.08**	**3.64**	**3.69**	**4.01**	**3.35**	**2.81**			
	Girls.		2.57	2.51	2.40	2.56	2.71	3.18	3.33	3.56	3.67	3.80	3.51	3.52	3.35	3.78	2.84	2.91
Strength of Squeeze, Right Hand	**Boys.**	Kilogramme	**1.41**	**1.52**	**1.95**	**2.45**	**2.66**	**2.74**	**3.17**	**4.27**	**4.15**	**5.10**	**5.29**					
	Girls.		1.39	1.67	1.87	2.11	2.27	2.42	2.83	3.31	4.11	3.65	3.77					
Strength of Squeeze, Left Hand.....	**Boys.**	Kilogramme	**1.43**	**1.72**	**2.08**	**2.66**	**2.57**	**2.70**	**3.11**	**3.50**	**3.93**	**5.10**	**5.58**	**4.87**				
	Girls.		1.47	1.62	2.00	2.10	2.23	2.36	2.98	3.35	3.90	3.84	3.93	3.17				
Length of Head.....	**Boys.**	Millimetre..	**4.21**	**4.57**	**4.85**	**4.87**	**4.13**	**5.26**	**4.56**	**4.55**	**5.44**	**4.66**	**4.93**	**5.08**	**4.13**			
	Girls.		4.20	4.22	4.26	4.39	4.33	4.70	4.46	4.55	4.53	4.58	5.12	4.09	3.20	4.09	3.75	
Width of Head.....	**Boys.**	Millimetre..	**2.82**	**3.58**	**3.68**	**3.74**	**3.85**	**3.76**	**3.61**	**3.90**	**3.82**	**4.03**	**3.48**	**4.21**	**3.88**			
	Girls.		3.81	3.86	3.66	3.65	3.96	3.80	4.03	3.92	3.96	3.84	4.17	3.60	3.85	4.14	3.64	
Root of Nose to Point of Chin	**Boys.**	Millimetre..	**5.09**	**4.80**	**4.67**	**4.82**	**4.77**	**5.18**	**5.22**	**5.54**	**5.21**	**5.21**	**4.79**	**6.57**	**4.92**			
	Girls.		4.80	4.45	4.46	4.48	4.64	4.61	5.05	4.68	4.94	4.98	4.91	5.15	3.79	3.77	4.01	3.66
Width of Face.....	**Boys.**	Millimetre..	**4.24**	**4.09**	**4.08**	**4.44**	**4.05**	**4.52**	**4.42**	**4.27**	**4.56**	**4.33**	**5.01**	**4.69**	**4.13**			
	Girls		4.30	3.92	3.97	4.02	4.38	4.17	4.26	4.45	4.26	4.08	4.07	4.08	3.38	3.76	3.58	3.08
Hair Line to Point of Chin.	**Boys.**	Millimetre..	**5.18**	**6.40**	**5.46**	**5.67**	**5.55**	**5.80**	**5.44**	**6.01**	**7.05**	**6.41**	**5.90**	**7.60**	**8.00**			
	Girls.		5.88	5.28	5.27	5.38	5.62	5.70	5.76	6.04	6.11	5.40	5.69	6.20	6.13	6.22	4.76	4.52

from the average. It is seen in this table that the probable deviations are small, that is, one-half of the observations deviate but little from the middle value, which is one of the fundamental attributes of deviations due to accidental causes. But additional evidence is hardly required, and few critics will object to regarding the middle values in this investigation as types of their respective series.

The objection sometimes made that the errors of observation materially affect the truth of the values obtained is of little weight, partly because such errors are "accidental" and compensate each other as already explained, and partly because a deviation from the middle value due to an uncompensated error in measurement forms, as a rule, an inconsiderable part of that greater deviation which expresses the physiological difference between the individual and the type of his age and class. Accidental errors of observation need not give concern in measurements of great numbers of school children. Nor need there be much fear of constant errors of observation, provided the collection of material is made by many persons and with a good number of each sort of measuring instrument. If hundreds of teachers take part in the measurements, as in the present investigation, a constant cause of error due to a teacher's unconscious bias or personal equation on one side of the middle value will very probably be compensated by the bias of another teacher on the opposite side, and, similarly, if a number of scales are used, the errors of those which weigh too lightly are likely to be compensated by the errors of those whose readings are too heavy.

The trustworthiness of this material must be encouraging to those whose hold on the theory underlying these matters is not very strong, because it illustrates the truth that the types of physical development, and the laws of growth of the type may be induced from measurements made by comparatively unskilled hands and demonstrates that a system of anthropometrical measurements may be fruitfully employed in the public schools.

The use to which middle values and the deviations from middle values shall be put is in part the subject of controversy, and it will be well to state here the manner in which they

shall be employed in the present work. In doing so it will be necessary to give a brief account of the matters concerning which agreement is general as well as those which are in dispute.

It is acknowledged generally that the method of Quetelet furnishes a middle value typical of the series from which it was drawn, for example the middle weight of boys of the same age, nationality and social condition is the typical weight of boys of that age and class; and it is further acknowledged that the increase in the middle value from year to year expresses the law of growth of the type. It follows that the middle value of those who stand at any deviation from the middle value of the whole number is the type of that degree of deviation from the type of the whole number and that the increase in the middle value at the same degree of deviation at each age in the period of growth expresses the law of growth of the type at that degree of deviation. Thus the curves of percentile grades printed below express the growth of the typical St. Louis school-boy and girl. The type at a certain deviation from the mean of an age will show the same degree of deviation from the mean at any subsequent age; for example a type-boy in the 75 percentile grade at age 6 will throughout his growth be heavier than 75 per cent. of boys of his own age. Percentile curves are of course not necessarily parallel. The type of the 50 per cent. who exceed the middle value of the whole number has a law of growth characteristic of tall boys and different from that of the type of the 50 per cent. who fall below the middle value of the whole number.

The application of the middle value to individuals has not yet been mentioned. It is here that controversy finds its hold. The relation of the individual to the type is not known. It is not known whether a boy who at age 6 is heavier than 75 per cent. of boys at his age will at age 18 be heavier than 75 per cent. of boys at that age. Some anthropologists believe that there is at least probability that children remain in the same percentile grade throughout life, while others dissent from this view. In truth the development of the individual has been little studied, and it is therefore not yet possible to state his probable future growth.

This question — the relation of the growth of the individual to the growth of the type — can be determined only by the individualizing method. The generalizing method deals solely with units, irrespective of their individuality. If for example John Smith in the 75 percentile grade and William Harrison in the 60 percentile grade at age 6 exchange places at age 7, the personal curve of each boy undergoes an important deviation, but the number of units in the two grades, and consequently the middle value in each, is unaltered. The generalizing method, therefore, furnishes no data by which the future development of individuals can be safely judged. The individualizing method, on the contrary, follows the individual from year to year throughout his growth and establishes the frequency and extent of his deviations from the growth of the type. The lack of data collected by the individualizing method is regrettable, but this gap in our knowledge does not prevent the establishing of physical standards by which the probability that the physique of any child is normal or abnormal can be fixed.

The facts stated above limit the application of middle values to (1) the establishing of physical standards at each age, and (2) the using of these standards to determine whether the physique of any child is normal: they do not, in the present state of knowledge, permit prediction of future growth.

It has been much disputed whether the median value or the average should be taken for the type. Many investigators agree with Sir John Herschel, who declares in his celebrated review of Quetelet's *Lettres sur la théorie des probabilités* (page 23) that an average "may be convenient, to convey a "general notion of the things averaged, but involves no con- "ception of a natural and recognizable central magnitude all "differences from which ought to be regarded as deviations "from a standard. The notion of a mean, on the other "hand, does imply such a conception, standing distinguished "from an average by this very feature, viz.: the regular "march of the groups, increasing to a maximum, and thence "again diminishing. An average gives us no assurance that "the future will be like the past. A mean may be reckoned "on with the most implicit confidence. All the phil-

"osophical value of statistical results depends on a due "appreciation of this distinction and acceptance of its "consequences."

Other statisticians have used the average exclusively. Out of respect to this difference of opinion, both the median value and the average have been employed in the present work. On calculating these values for each series, it was found that the difference between them was inconsiderable, showing that

TABLE No. 11.

Median Minus Average Values.

Dimensions.	Sex.	Unit of Measurement.	Age at Nearest Birthday, and Median Minus Average Values.						
			6	7	8	9	10	11	12
Weight.....	**Boys.**	Kilogramme	**+0.10**	**—0.01**	**+0.09**	**+0.16**	**+0.04**	**+0.08**	**—0.10**
	Girls.		+0.06	—0.01	—0.03	—0.04	—0.04	—0.35	—0.41
Height Standing....	**Boys.**	Centimetre..	**+0.29**	**+0.45**	**+0.64**	**+0.52**	**+0.68**	**+0.60**	**+0.36**
	Girls.		+0.43	+0.49	+0.38	+0.44	+0.42	+0.41	+0.43
Height Sitting.....	**Boys.**	Centimetre..	**—0.54**	**—0.10**	**+0.47**	**+0.35**	**—0.40**	**+0.42**	**+0.13**
	Girls.		+0.66	+0.64	+0.99	+0.03	+0.69	+0.59	+0.55
Span of Arms.....	**Boys.**	Centimetre..	**+0.62**	**+0.66**	**+0.66**	**+0.49**	**+0.39**	**+0.46**	**—0.12**
	Girls.		+0.33	+0.75	—0.20	+0.65	+0.43	+0.22	+0.53
Girth of Chest, Inspiration.	**Boys.**	Centimetre..	**+0.20**	**+0.30**	**+0.17**	**+0.49**	**+0.44**	**+0.47**	**+0.41**
	Girls.		+0.58	+0.28	+0.57	+0.56	+0.49	+0.55	+0.19
Girth of Chest, Expiration.	**Boys.**	Centimetre..	**+0.34**	**+0.24**	**+0.56**	**+0.37**	**+0.22**	**+0.40**	**+0.40**
	Girls.		+0.48	+0.51	+0.48	+0 48	+0.40	+0.48	+0.12
Strength of Squeeze, Right Hand.....	**Boys.**	Kilogramme	**+0.21**	**—0.02**	**+0.21**	**—0.70**	**—0.11**	**—0.08**	**—0.14**
	Girls.		+0.79	+0.03	+0.13	—0.09	—0.06	+0.27	—0.07
Strength of Squeeze, Left Hand.....	**Boys.**	Kilogramme	**+0.53**	**—0.04**	**—0.02**	**—0.19**	**—0.13**	**—0.23**	**—0.29**
	Girls.		+0.69	+0.54	—0.22	—0.18	—0.59	+0.02	+0.05
Length of Head.....	**Boys.**	Millimetre..	**+0.47**	**+0.38**	**+0.82**	**+0.28**	**+0.06**	**+0.49**	**+0.24**
	Girls.		+0.89	+0.49	+1.23	+1.41	+1.28	+1.67	+1.07
Width of Head.....	**Boys.**	Millimetre..	**+0.47**	**+0.61**	**+0.33**	**+0.21**	**+0.52**	**+0.31**	**+0.38**
	Girls.		+0.56	+0.70	+0.53	+0.54	+0.79	+0.49	+0.67
Root of Nose to Point of Chin.	**Boys.**	Millimetre..	**—0.52**	**—0.30**	**—0.20**	**—0.09**	**—0.33**	**—0.14**	**+0.20**
	Girls.		—0.53	—0.57	—0.05	—0.25	—0.37	—0.24	+0.07
Width of Face.....	**Boys.**	Millimetre..	**+0.96**	**+0.62**	**+0.93**	**+0.84**	**+0.03**	**+0.49**	**+0.78**
	Girls.		+0.68	+0.27	—0.18	+0.79	+0.93	+0.47	+0.63
Hair Line to Point of Chin.	**Boys.**	Millimetre..	**+0.34**	**+0.76**	**+0.54**	**+0.82**	**+0.33**	**+0.72**	**+0.39**
	Girls.		+0.39	+0.83	+0.41	+0.32	+0.52	+0.85	+0.66

TABLE No. 11 — *Continued.*

MEDIAN MINUS AVERAGE VALUES.

Age at Nearest Birthday, and Median Minus Average Values.									Dimensions.
13	14	15	16	17	18	19	20	21	
—0.36	**—0.46**	**—0.73**	**+0.23**	**—0.36**					
—0.49	+0.36	+0.16	—0.29	—0.09	+0.74	+0.28	—0.34		Weight.
+0.38	**+0.28**	**+0.35**	**+1.00**	**+0.87**	**+0.09**				
—0.34	+1.10	+0.78	+0.51	+0.07	+0.08	+1.10	+0.42	+0.52	Height Standing.
+0.29	**—0.13**	**—0.07**	**+0.94**	**+0.94**	**—0.53**				
+0.49	+0.93	+0.78	+0.74	+0.75	+0.69	+0.82	+0.69	+0.74	Height Sitting.
+0.24	**+0.34**	**+0.36**	**+1.35**	**+1.02**	**+0.19**				
+0.64	+0.98	—0.17	+0.80	+0.61	+0.91	+0.45	+1.33	—0.39	Span of Arms.
+0.39	**+0.23**	**+0.24**	**+1.01**	**+0.90**	**+1.23**				Girth of Chest,
+0.30	+0.43	+0.12	+0.57	+0.41	+0.48	+0.90	+0.80	—0.64	Inspiration.
+0.41	**+0.08**	**+0.52**	**+0.35**	**+0.72**	**+0.44**				Girth of Chest,
+0.40	+0.48	+0.17	+0.16	+0.26	+0.45	+0 51	+0.41	+0.61	Expiration.
—0.09	**—0.50**	**—0.52**	**—1.14**						Strength of Squeeze,
—0.62	—0.24	+0.31	—0.18	+0.37	+0.75	+0.43	—0.11		Right Hand.
—0.36	**—0.50**	**+0.08**	**+0.54**	**+0.60**					Strength of Squeeze,
—0.12	—0.69	+0.41	—0.08	—0.10	+0.02	+0.38	+0.48	—0.28	Left Hand.
+0.37	**—0.69**	**+0.68**	**+0.98**	**+1.48**	**—0.16**				
+1.04	+1.30	+0.55	+0.86	+0.46	+0.44	+0.40	+0.27		Length of Head.
+0.27	**+0.54**	**+0.78**	**+0.37**	**+0.41**	**+0.34**				
0.37	+0.35	+0.42	+0.72	+0.39	+1.07	+1.06	—0.12		Width of Head.
+0.10	**+0.08**	**—0.11**	**+0.10**	**+0.94**	**+0.16**				Root of Nose to
—0.21	—0.15	—0.39	—0.61	+0.46	+0.27	—0.38	+0.04	—0.06	Point of Chin.
+0.19	**+0.51**	**+0.71**	**+0.55**	**+1.79**	**+0.75**				
+0.71	+0.84	+0.45	+0.71	+0.75	+0.55	+0.20	+1.29		Width of Face.
—0.54	**+0.55**	**+0.78**	**—0.26**	**—0.03**	**+1.99**				Hair Line to
+0.80	+0.62	+0.65	+0.53	+0.90	+0.96	—1.83	—0.09	+1.78	Point of Chin.

either may be used for the type without any error of practical importance, provided the series are similar to those analyzed here. This point is of practical interest because the labor of reckoning the average is much greater than in reckoning the median value.

Bowditch, in *The Growth of Children*, Boston, 1891, p. 495 *et seq.*, discusses the relation of median and average value. "It is evident," he writes, "that the value M will tend to "approximate to the average value of all the observations and "will be identical with it when the [percentile] curve S T "is symmetrically disposed on both sides of M, *i. e.*, when "the values at sixty, seventy, eighty, ninety and ninety-five "per cent. exceed M by the same amount, respectively, by "which the values at forty, thirty, twenty, ten and five per "cent. fall short of it. If A represent the average value of "all the observations, then the value of M–A will be a meas-"ure of the direction and extent of the asymmetry of the "curve S T, *for this value will be zero when the curve is sym-"metrical, positive when the values at the lower percentile "grades fall short of M more than those at the higher grades "exceed it, and negative when the reverse is the case.*" [Dr. Bowditch now gives a table of median minus average height and weight.] "An examination of this table or of the curves "constructed from it, as given in Plate I, shows that the "asymmetry of the curves of percentile grades varies very "much, at different ages, both in direction and amount. The "variation in the value of M–A in the curves of height is much "the same as that in the curves of weight for each sex consid-"ered by itself, but there is a great difference between the "two sexes. This difference shows itself most distinctly "between the ages of eleven and fifteen years. During this "time a rise in the curves for the males coincides with a fall "in those for the females, while before and after this period "the curves, as a rule, rise and fall together. We must con-"clude, therefore, that the rate of annual increase, both in "height and weight, is different at different percentile grades, "or, in other words, that large children grow differently from "small ones, and moreover, that between the ages of eleven "and fifteen years there is a striking difference in the mode "of growth of the two sexes."

Table No. 11 and the curves constructed from it (Plates II, III, IV) furnish considerable material for the study of the relation between median and average values. The curves of median minus average height agree with those of Dr. Bowditch in showing (1) a difference in the rate of growth of the same sex at different percentile grades, (2) an agreement in the rate of growth of the sexes from age 6 to 12, inclusive,* and (3) a marked difference in the rate of growth from age 12 to age 16, beyond which the number of observations is perhaps too small for sure work. In the curves from both cities, moreover, the greatest asymmetry in girls is near age 13, and in boys near age 16, the culmination being a little later in St. Louis children, and the least asymmetry is near age 12. The asymmetry of Boston boys' curves at age 15 and girls' curves at ages 16 and 17 is somewhat greater than that of the St. Louis curves. It is further worthy of notice that the values in the case of St. Louis boys do not become negative.

There is a general similarity also between the median minus average weights of the children of the two cities, the asymmetry of girls being again greatest about age 14 and of boys greatest at about age 16. Dr. Bowditch's conclusions, quoted above, are therefore fully confirmed.

The St. Louis curves on Plates II, III and IV should now be compared with each other. The maximum asymmetry of girls about 14 years and boys about 16 years old, appears in weight, height, height sitting, and span of arms, while the remaining curves exhibit no characteristic sexual differences during the period of prepubertal acceleration. The asymmetry is for the most part positive, weight, strength of squeeze and height of face from root of nose to point of chin being the only considerable exceptions. Sexual differences, aside from those already mentioned, are unimportant, save perhaps in length and width of head, in both of which the asymmetry of girls is greater than that of boys from age 6 to age 13.

The errors in the median minus average values of height, weight and other single dimensions may be partially compen-

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* It should be remembered that Dr. Bowditch's ages are recorded at last birthday, while mine are recorded at nearest birthday.

sated by adding the median minus average values of several dimensions of each sex and age, without regard to plus or minus sign. This has been done in Table No. 12.

TABLE No. 12.

SUMS OF MEDIAN MINUS AVERAGE VALUES.

Age at Nearest Birthday.	Weight, Height Standing, Height Sitting, Span of Arms.		Girth of Chest at Full Inspiration and Expiration.		Strength of Squeeze, Right and Left Hand.		Head and Face Measurements.	
	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
6	1.55	1.48	0.54	1.06	0.74	1.48	2.76	3.05
7	1.22	1.89	0.54	0.79	0.06	0.57	2.67	2.86
8	1.86	1.60	0.73	1.05	0.23	0.35	2.82	2.40
9	1.52	1.16	0.86	1.04	0.89	0.27	2.24	3.31
10	1.51	1.58	0.66	0.89	0.24	0.65	1.27	3.89
11	1.56	1.57	0.87	1.03	0.31	0.29	2.15	3.72
12	0.71	1.92	0.81	0.31	0.43	0.12	1.99	3.10
13	1.27	1.96	0.80	0.70	0.45	0.74	1.47	3.13
14	1.21	3.37	0.31	0.91	1.00	0.93	2.37	3.26
15	1.51	1.89	0.76	0.29	0.60	0.72	3.06	2.46
16	3.52	2.34	1.36	0.73	1.68	0.26	2.26	3.43
17	3.19	1.52	1.62	0.67	....	0.47	4.65	2.96
18	....	2.42	1.77	0.93	....	0.77	3.40	3.29

The conclusions drawn from the curves discussed above are substantiated in the main by this table. It is, however, difficult to believe that a sexual difference such as exists in weight, height standing, height sitting and span of arms will not be found also in girth of chest and the various dimensions of the head. But a purely objective attitude towards the material in hand does not permit speculation as to what might be revealed if the material were very much larger and its intrinsic laws easier to unveil.

CHAPTER IV.

DANGERS OF COMPARING MEASUREMENTS OF CHILDREN IN DIFFERENT COUNTRIES. INFLUENCE OF OCCUPATION AND NATIONALITY OF PARENTS.

It has been a custom of anthropometrists to compare the type-children of cities, states or provinces very different in situation and character. Such comparisons may be expected always to show that the laws of growth are in their main features the same for all children. They cannot, however, be expected to give very definite information in regard to the relative size of children of different countries or districts so long as the social status or environment of the children is not more closely studied. The children in the public schools are from all classes of society, and it has been demonstrated repeatedly that the favored classes differ physically from the poor. The children of the prosperous have been found to be larger than the children of the poor. The comparison of middle values got from two sets of schools is therefore open to the objection that the composition of the school population may not be the same in both sets. It would for example be unsafe to say that St. Louis children are larger or smaller than Copenhagen children because the type-children in the St. Louis Public Schools are larger or smaller than the type-children in Copenhagen, for the difference observed may depend on the different composition of the school population in the two cities.

Such comparisons, when rightly made, are not only of great scientific interest but are almost essential to the use of anthropometrical systems in education. An immense saving of time would be made if it were shown that the typical height, weight, etc., of children in one city of a country could be adopted as the standard for the schools of the entire country or even a considerable part of it. And in any one city, the application of the type-values to individuals would be much less liable to error if it were known how much allowance should be made for the difference between the type

of a special social class and the types of a mixed school population. Every investigation of the present kind should, therefore, include information concerning the social condition of the children. The tax-returns are available for this purpose, and the occupation of parents is also of use. It was not possible to inquire into tax-returns in the present research, but some facts can be communicated regarding the physical differences between the children of professional and business men and those of manual tradesmen. The occupations included under these heads may be seen in the following statement of the occupations of the fathers of 2,000 St. Louis children. The names of occupations are set down as given by the pupils.

PROFESSIONS.

Artist	3	Minister	6
Chemist	1	Medical Student	1
Civil Engineer	3	Musician	6
Dentist	4	Photographer	3
Editor	6	Physician	13
Electrical Engineer	4	Teacher	9
Electrician	2	Veterinarian	1
Lawyer	14		
Total			76

MERCANTILE CLASS.

Agent	36	Dealer in Furniture	6
Banker	2	Hardware	2
Book-keeper	40	Hats	1
Broker	9	Horses	1
Cashier	8	Lime	1
Clerk	3	Lumber	4
Collector	8	Marble	1
Contractor	20	Pork	2
Dairyman	8	Produce	2
Druga	10	Stationery	1
Dealer in Butter	1	Stone	1
Carpets	2	Tobacco	5
Cattle	4	Wall-paper	1
Cloth	4	Foreman	24
Clothes	1	Grocer	36
Corn	2	Hotel-keeper	5
Coal	4	Inspector, Building	2
Feed and Flour	2	Street	7
Fish and Oysters	3	Not specified	1
Fruits	3	Jeweler	7

Insurance	4	President of Iron Co.	1
Manager	7	Publisher	1
Manufacturer	35	Real Estate	7
Merchant	143	Salesman	76
Merchant Tailor	2	Secretary of a corporation	6
News-depot	1	Telegrapher	1
Optician	2	Traveling Salesman	9
Postmaster	1	Undertaker	3

Total 579

MANUAL TRADES.

Baker	24	Maker of:	
Barber	23	Boilers	7
Blacksmith	29	Boxes	9
Book-Binder	2	Brushes	3
Brewer	14	Candies	3
Bricklayer	21	Carriages	16
Builder	9	Chains	2
Butcher	40	Chairs	2
Carpenter	148	Cigars	31
Carriage Repairer	2	Collars	1
Cigar Packer	1	Cornices	1
Cloth Sponger	1	Harness	2
Compositor	2	Lanterns	1
Confectioner	7	Mattresses	1
Cook	5	Models	1
Cooper	37	Organs	1
Coppersmith	1	Patterns	4
Cord-Wainer	1	Shoes	47
Dairyman	1	Tobacco	3
Decorator	4	Trunks	1
Draughtsman	5	Wagons	6
Dressmaker	4	Watches	6
Dyer	2	Machinist	55
Engineer	43	Maltster	4
Engraver	1	Marble Cutter	3
Fireman	11	Mechanic	42
Foundryman	2	Miller	7
Gardener	5	Millwright	5
Gilder	1	Miner	1
Glass Blower	2	Molder	33
Iron Worker	3	Motorman	2
Laundryman	1	Packer	5
Lithographer	1	Painter	51
Locksmith	1	Paper-Hanger	8
Maker of:		Paver	4
Bags	2	Pipe-Fitter	2
Baskets	1	Planer	1
Belts	1	Plasterer	10

Plumber	13	Tailor	56
Polisher	1	Tanner	6
Potter	2	Tinner	15
Printer	19	Turner	6
Puddler	1	Upholsterer	5
Saddler	12	Varnisher	5
Selector of Tobacco	1	Waterproofer and Painter	1
Shoe Varnisher	1	Weaver	1
Slater	1	Whitener	14
Stair Builder	4	Wood-Worker	33
Stone Mason	50		
Total			1086

LABORERS.

Baggageman	2	Oiler	2
Carriers, Letter	9	Peddler	19
Carriers, Paper	6	Policeman and watchman	21
Coal-heaver	1	Porter	4
Driver	3	Riverman	1
Elevator man	1	Railway-hand	12
Engine-cleaner	1	Saloon-keeper	51
Expressman	3	Sexton	1
Fireman	11	Shepherd	1
Gripman	6	Steward, Hotel	2
Hostler	7	" Steamer	1
Huckster	2	"	3
Janitor	3	Teamster	6
Laborer	31	Waiter	1
Live-stock driver	1		
Lumberman	1	Total	216
Mill-hand	4		

MISCELLANEOUS.

Captain of Steamer	1
Conductor	14
Farmer	12
"Independent"	1
Pilot	5
No occupation	7
"Retired"	3
Total	43

SUMMARY.

Professions	76
Mercantile classes	579
Manual trades	1086
Laborers	216
Miscellaneous	43
Total	2000

The number of children of rich families and of very poor families in the public schools is small, the larger part of the pupils being from what would be called in England the lower middle class, and the school population is accordingly more homogeneous than would have seemed possible at the first glance.

The difference in the weight of children of the professional and merchant class is probably of little importance until the period of prepubertal acceleration. Such at least is the inference from Table No. 13, where the weights of these two classes are compared.

TABLE No. 13.

A Comparison of the Weights of the Daughters of Manual Tradesmen with the Weights of the Daughters of Professional Men and Merchants.

Professional Men and Merchants.			Manual Tradesmen.		
Age at Nearest Birthday.	Number of Observations.	Median Weight. (Kilogrammes)	Median Weight. (Kilogrammes)	Number of Observations.	Age at Nearest Birthday.
6	74	19.53	18.95	237	6
7	148	20.63	20.74	604	7
8	170	23.00	22.89	723	8
9	152	25.48	25.09	688	9
10	168	27.61	27.46	651	10
11	173	30.63	29.45	569	11
12	153	33.86	32.28	556	12
13	160	39.04	37.07	402	13
14	140	43.59	41.68	251	14
15	112	47.49	45.62	145	15
16	87	50.16	49.18	52	16
17	46	53.58	51.07	24	17

What is true of weight is in this instance probably true of the physical development as a whole, and Table No. 13 would seem to indicate that a wide difference in social status or material prosperity may exist without much influencing the growth of children up to the prepubertal acceleration. But further investigation is necessary before a generalization can be made. It must suffice here to state: 1. The daughters of professional men and merchants are very little heavier than the daughters of manual tradesmen until the period of pre-

pubertal acceleration. 2. The weight of girls is much more influenced by the material prosperity or social status of parents during and immediately after the period of pre-pubertal acceleration than in the earlier years of growth.

The proportion of children of the more prosperous class in the public schools is not the same in all grades. In the higher grades, containing the older children, the number from prosperous families is relatively larger, the children of the poor having in many instances been compelled to leave school in order to earn money. Some idea of the extent of this change may be gained from Table No. 14, in which the per cent. of daughters of professional men and merchants and daughters of manual tradesmen is given at each age and school grade.

TABLE No. 14.

THE PERCENTILE DISTRIBUTION BY SCHOOL GRADE OF THE DAUGHTERS OF MERCHANTS AND PROFESSIONAL MEN (*i. e.* FAVORED CLASSES) COMPARED WITH THAT OF THE DAUGHTERS OF MANUAL TRADESMEN (HAND-WORKERS).

Age at nearest Birthday.	Number of Individuals.	Percentile Distribution by School Grades.									
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	
Six	44	95.4	4.6								Professions.
	141	91.5	8.5								Trades.
Seven	102	46.1	48.0	5.9							Professions.
	341	40.0	54.8	5.2							Trades.
Eight	105	2.0	49.5	46.6	2.0						Professions.
	440	2.0	65.4	30.9	1.4	0.2					Trades.
Nine	110		10.0	60.0	23.6	4.5	1.8				Professions.
	439		23.7	57.8	16.2	2.3					Trades.
Ten	119		1.7	26.9	45.4	23.5	1.7	0.8			Professions.
	386		5.7	39.9	44.3	8.5	1.0	0.5			Trades.
Eleven	116		0.9	12.0	24.1	50.0	11.2	0.9	0.9		Professions.
	355		2.5	15.5	41.2	33.0	7.6	0.8			Trades.
Twelve	108		0.9	3.7	13.9	37.0	28.7	13.0	0.9	1.9	Professions.
	357		0.6	7.6	19.6	40.0	21.8	9.8	0.3		Trades.
Thirteen	121			2.5	4.1	18.9	31.4	24.8	11.6	6.6	Professions.
	304		0.7	3.3	12.2	27.3	25.0	20.7	9.9	1.0	Trades.
Fourteen	89				3.4	5.6	18.0	32.6	20.2	20.2	Professions.
	177			1.1	4.5	14.7	25.4	29.2	15.8	9.0	Trades.
Fifteen	65				1.5	1.5	10.8	29.2	21.5	35.4	Professions.
	110				1.8	7.1	14.5	32.7	20.0	23.6	Trades.
Sixteen	37					2.7	2.7	21.6	35.1	37.7	Professions.
	24					4.2	8.3	16.7	29.2	41.7	Trades.

The ratio between the two is more easily grasped when the difference between the classes at each age and grade is stated, black type being used where the professional and merchant class exceed the tradesmen's daughters and lower case type where the contrary is true.

Age.	Kinder-garten.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.
6	**3.9%**	3.9%	%	%	%	%	%	%	%
7	**6.1**	6.8	**0.7**	.....	.....	.....	.....	.....	.....
8	0.0	15.9	**15.7**	**0.6**	.....	.....	.....	.....	.....
9	.....	13.7	**2.2**	**7.4**	**2.2**	.....	.....	.....	.....
10	.....	4.0	13.0	**1.1**	**15.0**	**0.7**	**0.3**	.....	.....
11	.....	1.6	3.5	17.1	**17.0**	**3.6**	**0.1**	.....	.....
12	.....	**0.3**	3.9	5.7	3.0	**6.9**	**3.2**	**0.6**	.....
13	.....	.....	0.8	8.1	8.4	**6.4**	**4.1**	**1.7**	**5.6**
14	.....	.....	.....	1.1	9.1	7.4	**3.4**	**4.4**	**11.2**
15	.....	.....	.....	0.3	5.6	3.7	3.5	**1.5**	**11.8**
16	.....	.....	.....	.....	1.5	5.6	**4.9**	**5.9**	**4.0**

The number of boys withdrawn from school to earn money is of course greater than the number of girls withdrawn. Thus of 562 boys, aged 6, 17.8 per cent. were sons of professional men or merchants and 42.9 per cent. sons of manual tradesmen, while at age 14, 29.3 per cent. of 498 boys were from the former class and 37 per cent. from the latter.

Age at Nearest Birthday.	Number of Individuals.	Sons of Professional Men and Merchants.	Sons of Manual Tradesmen.	Others.
6	562	17.8%	42.9%	39.3%
14	498	29.3	37.0	33.7

The nationality of the children should be considered in an anthropometrical inquiry. It is well known that children of the same age but different nationality exhibit differences in physical development. The annual report of the Superintendent of Public Schools, issued Aug. 1, 1891, contains in Table V, appendix, page XLVI, a statement "Showing the Birthplace of Pupils Registered in Each School for the Year 1890–91," from which the number of pupils in the schools in which the measurements were made has been taken and the following percentages calculated: —

BIRTHPLACE OF 46,870 PUPILS IN THE ST. LOUIS PUBLIC SCHOOLS.

St. Louis	79.26 %
Other Parts of the United States	16.92 "
Great Britain	0.63 "
Ireland	0.19 "
German States	1.97 "
Other Foreign Countries	0.87 "
Unknown	0.16 "
Total	100

The children of foreign birth are too few to affect the results of the measurements, and the number of children born in or near St. Louis is such that the middle values obtained must be taken as characteristic for this community.

The children of foreign parentage are of course much more numerous than those of foreign birth. The number of Germans is especially large. The median weights of boys and girls whose parents were born in Germany are compared in Tables No. 15 and 16, with children of American parentage.

TABLE No. 15.*

THE WEIGHTS OF GIRLS WHOSE PARENTS WERE BORN IN GERMANY COMPARED WITH THE WEIGHTS OF GIRLS WHOSE PARENTS WERE BORN IN THE UNITED STATES.†

GERMAN.			AMERICAN.		
Age at Nearest Birthday.	Number of Observations.	Median Weight. (Kilogrammes)	Median Weight. (Kilogrammes)	Number of Observations.	Age at Nearest Birthday.
6	310	19.15	18.76	398	6
7	683	20.86	20.82	861	7
8	796	23.17	22.71	1082	8
9	796	25.09	25.07	1023	9
10	725	27.65	27.43	1029	10
11	753	29.61	29.93	808	11
12	715	33.42	33.17	779	12
13	518	37.58	38.29	648	13
14	331	42.56	43.12	565	14
15	186	46.77	46.90	403	15
16	86	49.73	50.06	265	16
17	49	53.93	52.12	131	17
18	43	52.59	54.03	100	18
19	22	54.26	52.90	40	19
20			52.67	33	20

* The birth-place of the girls themselves is not considered in this table.

† A few were born in Canada.

TABLE No. 16.*

THE WEIGHTS OF BOYS WHOSE PARENTS WERE BORN IN GERMANY COMPARED WITH THE WEIGHTS OF BOYS WHOSE PARENTS WERE BORN IN THE UNITED STATES.†

GERMAN.			AMERICAN.		
Age at Nearest Birthday.	Number of Observations.	Median Weight. (Kilogrammes)	Median Weight. (Kilogrammes)	Number of Observations.	Age at Nearest Birthday.
6	158	20.04	19.66	263	6
7	334	21.93	21.67	756	7
8	426	23.98	23.91	907	8
9	369	26.64	26.08	878	9
10	370	28.51	28.49	847	10
11	358	31.21	31.26	663	11
12	385	33.51	33.45	549	12
13	321	35.92	35.96	437	13
14	166	39.59	40.34	352	14
15	106	44.68	47.25	219	15
16	26	52.22	52.10	92	16
			55.14	40	17

The difference in weight is seen to be of no great importance.

In the absence of special investigations of the influence of social condition and the nationality of parents on the growth of children, it is impossible to estimate accurately to what degree middle values, calculated without regard to social condition and nationality, are affected by these factors. The data presented in this chapter go to show that the middle values of St. Louis children are little influenced by considerable differences in social condition before the period of prepubertal acceleration and are not very largely influenced by such differences during this period. Further, these values are at no time much affected by differences in nationality of parents not greater than those existing between Germans and Americans. But the whole question evidently requires extended study of data difficult or impossible of collection by private hands.

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* The birth-place of the boys themselves is not considered in this table.

† A few were born in Canada.

CHAPTER V.

PERCENTILE GRADES OF WEIGHT, HEIGHT STANDING, HEIGHT SITTING, SPAN OF ARMS, GIRTH OF CHEST, LENGTH OF HEAD, WIDTH OF HEAD, HEIGHT OF FACE FROM ROOT OF NOSE TO POINT OF CHIN, WIDTH OF FACE, AND HEIGHT OF FACE FROM HAIR LINE TO POINT OF CHIN.

The Percentile Grades of weight, height, etc., presented in Tables No. 17 to No. 28, inclusive, are represented graphically in Plates V to XXIV. By their aid, the percentile rank of an individual in respect of weight, span of arms or any physical dimension included in the tables can be easily and quickly determined. Suppose, for example, the percentile rank of a boy, aged 11, weighing 32 kg. was desired. A horizontal line is drawn from 32 in the column of kilogrammes on the left of Plate V to the curve of age 11, and a perpendicular is dropped from the point of intersection to the scale of percentile grades at the bottom of the plate. The perpendicular falls at 60 per cent. Hence the boy is heavier than 60 per cent. of boys of his age and lighter than 40 per cent.

Other facts are made plain by these curves. The increase at any percentile grade during one or more years is expressed by the distance between the curves at that grade. Thus, in Plate V, the gain in weight of the type-boy in the 15 percentile grade during the years 6 to 11 inclusive is 9.3 kg., and the gain at the 85 percentile grade during the same year 13.0 kg. The difference in size between large and small boys of the same age appears in the inclination of the curve to its axis, the slope being steepest in the years of quickest growth. And finally, the tendency of the greater number of individuals to approximate the middle value of their group is illustrated, the inclination of each curve being much less at the central part than at the ends, where the giants and the dwarfs are found. The principal service of such curves, however, is to determine percentile rank.

TABLE No. 17.

The Weight.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Kilogrammes at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Kilogram.
Six	**Boys.**	**707**	**16.51**	**17.37**	**18.31**	**18.83**	**19.35**	**19.85**	**20.32**	**20.82**	**21.71**	**22.81**	**23.78**	**19.75**
	Girls.	798	16.00	16.60	17.39	18.01	18.45	18.99	19.49	20.03	20.85	22.06	22.99	18.93
Seven	**Boys.**	**1814**	**18.17**	**18.85**	**19.77**	**20.50**	**21.03**	**21.66**	**22.24**	**22.91**	**23.80**	**25.26**	**26.50**	**21.67**
	Girls.	1714	17.16	17.95	18.88	19.62	20.24	20.81	21.39	22.13	22.96	24.36	25.75	20.82
Eight	**Boys.**	**2188**	**19.49**	**20.44**	**21.60**	**22.40**	**23.10**	**23.87**	**24.60**	**25.36**	**26.34**	**27.89**	**29.15**	**23.78**
	Girls.	2147	18.83	19.61	20.64	21.40	22.17	22.85	23.60	24.31	25.29	27.08	28.38	22.88
Nine	**Boys.**	**2188**	**21.56**	**22.65**	**23.75**	**24.59**	**25.30**	**26.22**	**26.93**	**27.78**	**28.77**	**30.15**	**32.19**	**26.06**
	Girls.	2055	20.45	21.40	22.65	23.49	24.25	25.04	25.82	26.77	27.85	29.60	31.24	25.08
Ten	**Boys.**	**2064**	**22.97**	**24.19**	**25.57**	**26.57**	**27.53**	**28.36**	**29.34**	**30.19**	**31.42**	**33.18**	**34.76**	**28.32**
	Girls.	1947	21.93	23.18	24.49	25.66	26.57	27.45	28.28	29.33	30.58	32.29	34.16	27.49
Eleven	**Boys.**	**1743**	**25.31**	**26.35**	**27.89**	**29.11**	**30.03**	**31.08**	**32.01**	**32.96**	**34.35**	**36.14**	**37.97**	**31.00**
	Girls.	1708	23.88	25.26	26.78	27.78	28.86	29.80	30.94	32.12	33.56	36.37	38.35	30.15
Twelve	**Boys.**	**1644**	**27.47**	**28.57**	**30.05**	**31.25**	**32.43**	**33.41**	**34.39**	**35.59**	**36.93**	**39.21**	**41.43**	**33.51**
	Girls.	1676	26.23	27.70	29.40	30.70	31.88	33.25	34.50	35.98	37.67	40.98	44.78	33.66
Thirteen	**Boys.**	**1242**	**29.29**	**30.47**	**32.14**	**33.62**	**34.82**	**36.25**	**37.37**	**38.90**	**40.81**	**43.40**	**47.38**	**36.61**
	Girls.	1343	29.19	30.78	33.05	34.67	36.25	38.00	39.81	41.80	43.77	47.49	50.25	38.49
Fourteen	**Boys.**	**946**	**32.02**	**33.67**	**35.70**	**37.11**	**38.50**	**39.98**	**41.98**	**43.98**	**46.78**	**50.32**	**53.96**	**40.44**
	Girls.	1082	31.50	34.14	36.73	39.01	40.87	42.65	44.30	46.48	48.61	51.94	54.99	42.29
Fifteen	**Boys.**	**498**	**35.76**	**37.05**	**39.02**	**41.05**	**43.17**	**45.49**	**47.76**	**50.17**	**53.33**	**57.11**	**60.29**	**46.22**
	Girls.	690	36.48	38.54	41.81	43.37	45.26	46.85	48.05	49.65	51.67	54.86	58.05	46.69
Sixteen	**Boys.**	**203**	**37.72**	**39.87**	**44.55**	**46.77**	**49.51**	**51.83**	**54.53**	**56.88**	**58.99**	**63.87**	**67.16**	**51.60**
	Girls.	420	39.86	42.09	45.63	47.48	48.87	49.96	51.56	53.08	55.84	59.31	61.56	50.25
Seventeen	**Boys.**	**71**	**45.45**	**47.45**	**51.34**	**52.54**	**54.30**	**55.31**	**57.68**	**60.24**	**62.17**	**63.91**	**64.87**	**55.67**
	Girls.	230	44.27	45.66	47.78	49.56	51.30	52.52	54.28	55.61	57.32	60.15	63.22	52.61
Eighteen	Girls.	155	45.65	46.99	48.51	50.03	52.06	53.10	54.23	55.70	57.96	60.76	64.33	52.36
Nineteen	Girls.	81	44.05	45.45	47.87	49.99	51.48	52.47	53.62	54.68	56.80	59.84	61.72	52.19
Twenty	Girls.	66	45.54	47.31	49.08	50.94	52.72	53.57	55.02	55.57	59.09	63.02	66.11	53.91

TABLE No. 18.

The Height Standing.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Centimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six.....	**Boys.**	**709**	**101.77**	**103.50**	**105.25**	**106.73**	**107.90**	**109.23**	**110.40**	**111.86**	**113.51**	**115.81**	**118.32**	**108.94**
	Girls.	780	100.20	101.41	103.97	105.51	106.78	108.10	109.40	110.61	111.98	115.00	116.90	107.67
Seven	**Boys.**	**1850**	**105.67**	**107.56**	**110.23**	**111.81**	**112.97**	**114.48**	**115.81**	**117.13**	**118.90**	**121.24**	**123.39**	**114.03**
	Girls.	1791	104.93	106.24	108.93	110.51	111.89	113.44	115.03	116.32	117.82	120.38	121.94	112.95
Eight.....	**Boys.**	**2223**	**109.68**	**112.28**	**115.15**	**117.01**	**118.44**	**119.78**	**121.23**	**122.72**	**124.44**	**126.73**	**129.05**	**119.13**
	Girls.	2193	110.18	111.86	114.32	115.82	117.40	118.75	120.16	121.42	123.27	125.79	127.79	118.36
Nine.....	**Boys.**	**2205**	**115.89**	**118.11**	**120.29**	**121.90**	**123.38**	**124.87**	**126.25**	**127.87**	**129.64**	**131.90**	**134.06**	**124.35**
	Girls.	2122	115.17	117.12	119.59	121.21	122.76	124.11	125.53	126.54	128.62	130.97	133.42	123.67
Ten	**Boys.**	**2087**	**120.04**	**121.92**	**124.58**	**126.40**	**127.98**	**129.45**	**130.98**	**132.54**	**134.53**	**137.14**	**139.45**	**128.87**
	Girls.	2053	119.43	121.34	124.14	125.77	127.32	128.85	130.33	131.82	133.33	136.86	138.84	128.43
Eleven	**Boys.**	**1819**	**124.53**	**126.59**	**129.11**	**130.95**	**132.75**	**134.44**	**135.85**	**137.24**	**139.33**	**142.18**	**144.75**	**133.84**
	Girls.	1772	122.95	125.41	128.16	130.29	132.08	133.60	135.25	136.87	139.06	142.16	144.69	133.19
Twelve.	**Boys.**	**1653**	**128.65**	**130.59**	**133.26**	**135.23**	**136.87**	**138.57**	**140.41**	**141.94**	**144.05**	**147.02**	**149.83**	**138.21**
	Girls.	1732	128.06	130.66	133.53	135.68	137.55	139.54	141.38	143.29	145.58	149.16	152.19	139.11
Thirteen	**Boys.**	**1268**	**131.36**	**134.14**	**137.39**	**139.51**	**141.39**	**143.29**	**145.12**	**147.01**	**149.54**	**153.55**	**155.91**	**142.91**
	Girls.	1322	134.16	137.09	139.84	142.12	144.23	146.19	148.26	150.68	152.90	156.03	158.63	146.53
Fourteen	**Boys.**	**925**	**137.10**	**139.63**	**142.30**	**144.56**	**146.50**	**148.86**	**150.67**	**153.26**	**155.77**	**159.19**	**162.88**	**148.58**
	Girls.	1085	139.02	141.66	145.68	148.01	150.25	151.94	153.70	155.37	157.26	160.31	161.99	150.84
Fifteen	**Boys.**	**490**	**140.94**	**143.69**	**147.50**	**150.26**	**152.65**	**155.25**	**157.47**	**160.19**	**163.53**	**168.00**	**170.44**	**154.90**
	Girls.	680	145.11	148.20	150.82	152.68	154.28	155.82	156.89	158.60	160.55	162.77	164.83	155.04
Sixteen.....	**Boys.**	**189**	**146.42**	**149.38**	**153.93**	**156.62**	**159.45**	**161.27**	**163.08**	**165.47**	**168.60**	**171.02**	**173.55**	**160.27**
	Girls.	420	149.00	150.45	153.05	154.82	156.52	158.03	159.54	160.97	162.65	165.93	167.64	157.52
Seventeen	**Boys.**	**78**	**154.90**	**156.90**	**159.72**	**161.85**	**164.20**	**166.00**	**168.13**	**170.20**	**172.48**	**175.07**	**177.05**	**165.13**
	Girls.	206	150.43	152.46	154.73	156.57	157.77	159.40	160.54	162.02	163.83	166.23	168.46	159.33
Eighteen.....	Girls.	164	151.10	153.47	155.73	157.13	158.54	**170.50** 159.50	160.57	162.26	164.31	166.45	169.60	159.42
Nineteen.....	Girls.	85	150.13	151.36	153.00	155.64	158.43	159.56	160.83	162.42	164.11	165.17	167.76	158.46

TABLE No. 19.

The Height Sitting.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Centimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six.....	**Boys.**	**714**	**56.28**	**57.50**	**58.71**	**59.50**	**60.17**	**60.77**	**61.52**	**62.42**	**63.61**	**65.31**	**68.58**	**61.31**
	Girls.	751	55.19	56.28	57.68	58.78	59.41	60.11	60.80	61.59	62.50	63.68	64.75	59.45
Seven.....	**Boys.**	**1853**	**58.41**	**59.50**	**60.72**	**61.60**	**62.42**	**63.22**	**63.98**	**64.77**	**65.66**	**67.38**	**69.19**	**63.32**
	Girls.	1727	57.41	58.65	60.16	60.99	61.80	62.44	63.28	64.12	65.00	66.08	67.20	61.80
Eight.....	**Boys.**	**2239**	**60.21**	**61.38**	**62.70**	**63.74**	**64.52**	**65.21**	**65.87**	**66.69**	**67.65**	**69.01**	**70.32**	**64.74**
	Girls.	2120	60.22	61.00	62.27	63.14	64.01	64.96	65.22	65.82	66.92	68.21	69.27	63.97
Nine.....	**Boys.**	**2258**	**62.10**	**63.16**	**64.59**	**65.50**	**66.29**	**67.08**	**67.93**	**68.82**	**69.79**	**71.17**	**72.43**	**66.73**
	Girls.	2071	61.79	62.99	64.26	65.30	66.00	66.19	67.52	68.33	69.28	70.59	71.81	66.16
Ten.....	**Boys.**	**2118**	**63.70**	**65.49**	**66.35**	**67.45**	**68.37**	**69.18**	**69.98**	**70 84**	**71.86**	**73.46**	**74.79**	**69.25**
	Girls.	2037	63.46	64.86	66.19	67.22	68.06	68.88	69.61	70.48	71.49	72.79	74.02	68.19
Eleven.....	**Boys.**	**1828**	**65.23**	**66.62**	**68.29**	**69.27**	**70.23**	**71.09**	**71.84**	**72.70**	**73.75**	**75.23**	**76.63**	**70.67**
	Girls.	1748	65.15	66.27	67.83	68.08	69.89	70.62	71.42	72.36	73.51	75.08	76.37	70.03
Twelve.....	**Boys.**	**1656**	**67.62**	**68.35**	**70.08**	**70.89**	**71.84**	**72.68**	**73.56**	**74.50**	**75.56**	**77.00**	**78.81**	**72.55**
	Girls.	1707	66.06	68.46	70.21	71.16	72.39	73.22	74.21	75 26	76.29	78.24	79.09	72.67
Thirteen.....	**Boys.**	**1285**	**68.68**	**70.02**	**71.45**	**72.61**	**73.58**	**74.49**	**75.75**	**76.27**	**77.48**	**79.24**	**81.00**	**74.20**
	Girls.	1354	69.99	71.44	73.15	74.40	75.46	76.52	77.64	78.47	80.41	82.06	83.48	76.03
Fourteen.....	**Boys.**	**936**	**70.49**	**71.78**	**73.76**	**74.97**	**75.83**	**76.71**	**77.84**	**79.03**	**80.71**	**82.85**	**85.37**	**76.84**
	Girls.	1065	71.54	73.83	75.79	77.20	78.29	79.61	80.59	81.59	82.87	84.74	85.95	78.68
Fifteen.....	**Boys.**	**498**	**72.66**	**74.28**	**75.84**	**77.17**	**78.41**	**79.67**	**81.08**	**82.70**	**84.75**	**86.58**	**88.51**	**79.74**
	Girls.	674	75.34	77.05	79.17	80.34	81.27	82.20	83.12	84.04	85.12	86.55	87.72	81.42
Sixteen.....	**Boys.**	**193**	**74.66**	**76.37**	**78.73**	**80.00**	**82.00**	**83.22**	**84.57**	**85.78**	**86.86**	**89.14**	**91.39**	**82.28**
	Girls.	411	78.93	80.77	81.67	82.65	83.54	84.50	85.34	86.00	87.03	88.11	89.57	83.76
Seventeen	**Boys.**	**77**	**77.84**	**79.84**	**82.47**	**84.22**	**85.42**	**86.22**	**88.03**	**89.10**	**90.00**	**92.32**	**94.07**	**85.68**
	Girls.	202	80.44	81.62	82.19	83.81	84.66	85.41	86.20	86.90	87.70	89.10	90.32	84.66
Eighteen	**Boys.**	**31**		**84.10**	**85.40**	**86.32**	**87.08**	**87.70**	**89.60**	**91.57**	**93.20**	**93.98**	**94.72**	**88.23**
	Girls.	167	81.47	82.44	83.78	84.74	85.37	85.89	86.51	87.18	87.94	88.85	90.87	85.20
Nineteen.....	Girls.	85	80.81	81.58	83.50	84.42	85.07	85.68	86.29	86.89	87.64	88.56	89.75	84.86
Twenty	Girls.	78	80.95	82.13	83.65	84.64	85.35	86.00	86.78	87.66	88.49	89.60	90.28	85.31

TABLE No. 20.

The Span of Arms.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Centimetres at the following Percentile Grades.											Average, Centimetr's
			5	10	20	30	40	50	60	70	80	90	95	
Six	**Boys.**	**708**	**100.76**	**102.45**	**105.00**	**106.32**	**108.27**	**109.57**	**110.70**	**112.94**	**114.26**	**117.00**	**119.00**	**108.95**
	Girls.	769	98.43	100.36	102.87	105.49	106.57	106.96	108.77	110.42	112.39	115.16	117.07	106.96
Seven	**Boys.**	**1862**	**105.23**	**107.30**	**110.17**	**112.00**	**113.58**	**115.08**	**116.19**	**117.88**	**119.85**	**122.26**	**124.18**	**114.42**
	Girls.	1724	103.14	105.21	107.60	109.81	111.34	113.11	114.70	116.63	117.91	120.65	122.76	112.36
Eight	**Boys.**	**2234**	**110.28**	**112.75**	**115.60**	**117.44**	**119.13**	**120.73**	**122.22**	**123.66**	**125.76**	**128.43**	**130.49**	**120.07**
	Girls.	2152	108.52	111.85	113.79	115.61	117.29	118.13	120.38	121.94	123.11	126.80	128.90	118.34
Nine	**Boys.**	**2272**	**115.76**	**118.18**	**120.70**	**122.40**	**124.14**	**125.67**	**127.15**	**128.99**	**130.86**	**133.84**	**136.45**	**125.18**
	Girls.	2065	113.60	115.85	119.19	121.11	122.57	124.28	125.75	127.37	129.46	131.96	134.75	123.63
Ten	**Boys.**	**2076**	**119.57**	**122.15**	**125.21**	**127.16**	**129.03**	**130.61**	**132.47**	**134.48**	**136.49**	**139.66**	**141.74**	**130.22**
	Girls.	2045	118.24	120.67	123.63	125.63	127.30	129.18	130.77	132 54	134.94	138.81	140.89	128.75
Eleven	**Boys.**	**1810**	**124.46**	**126.77**	**129.92**	**131.87**	**133.79**	**135.59**	**137.58**	**139.64**	**141.50**	**144.67**	**147.25**	**135.13**
	Girls.	1757	122.78	125.27	128.22	130.62	132.61	134.56	136.17	138.17	140.78	144.92	147.00	134.24
Twelve.....	**Boys.**	**1664**	**128.55**	**131.00**	**134.51**	**136.58**	**138.69**	**140.48**	**142.30**	**144.35**	**146.50**	**150.18**	**153.19**	**140.60**
	Girls.	1718	127.45	130.34	133.90	136.33	138.59	140.60	142.50	144.74	147.36	151.32	154.36	140.07
Thirteen	**Boys.**	**1281**	**132.33**	**135.35**	**138.75**	**141.40**	**143.28**	**145.33**	**147.43**	**150.05**	**152.69**	**156.96**	**159.62**	**145.09**
	Girls.	1368	134.95	137.49	140.69	143.50	145.88	147.83	150.25	152.18	154.59	158.40	160.55	147.19
Fourteen	**Boys.**	**934**	**138.21**	**141.06**	**144.72**	**147.28**	**149.48**	**151.62**	**154.11**	**156.00**	**158.72**	**163.20**	**167.32**	**151.28**
	Girls.	1088	139.60	142.92	146.81	149.79	151.84	153.56	155.36	157.38	159.70	162.38	164.70	152.58
Fifteen.....	**Boys.**	**495**	**140.96**	**145.36**	**150.32**	**153.30**	**156.21**	**158.79**	**161.24**	**164.00**	**168.07**	**173.17**	**177.53**	**158.43**
	Girls.	677	145.68	148.48	151.29	153.94	155.32	156.21	158.52	160.43	162.39	165.55	168.24	156.38
Sixteeen	**Boys.**	**189**	**145.82**	**150.22**	**156.30**	**159.78**	**162.74**	**165.31**	**167.91**	**169.88**	**173.10**	**176.89**	**180.55**	**163.96**
	Girls.	413	148.13	150.55	154.35	156.43	157.61	159.31	160.80	162.26	164.26	167.39	170.15	158.51
Seventeen	**Boys.**	**75**	**154.50**	**159.50**	**163.66**	**165.87**	**167.75**	**169.58**	**170.83**	**174.10**	**176.66**	**180.25**	**183.50**	**168.56**
	Girls.	202	149.20	151.40	154.43	156.29	157.88	159.62	160.88	162.53	164.37	167.13	169.30	159.01
Eighteen	**Boys.**	**32**	**166.20**	**168.10**	**170.40**	**171.87**	**172.93**	**175.50**	**177.40**	**178.47**	**181.40**	**184.80**	**186.40**	**175.31**
	Girls.	164	150.30	152.68	155.54	157.76	160.05	161.38	162.65	164.52	166.30	169.10	170.93	160.47
Nineteen	Girls.	83	147.00	151.30	154.60	155.74	157.05	158.90	160.83	161.89	164.28	168.70	170.28	158.45
Twenty	Girls.	76	151.80	153.80	155.64	157.26	158.80	161.50	162.93	164.03	165.93	168.47	169.55	160.17
Twenty-one ..	Girls.	37		153.70	156.47	158.33	159.80	160.88	163.80	165.95	167.40	169.50	171.15	161.27

TABLE No. 21.

The Girth of Chest at Full Inspiration.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Centimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six	**Boys.**	**674**	**56.05**	**57.13**	**58.72**	**59.87**	**60.36**	**61.04**	**61.73**	**62.59**	**63.75**	**65.59**	**67.04**	**60.84**
	Girls.	739	54.77	56.41	57.52	58.64	59.51	60.26	60.92	61.69	62.81	64.42	66.04	59.68
Seven	**Boys.**	**1702**	**57.74**	**58.98**	**60.26**	**61.25**	**62.47**	**62.86**	**63.70**	**64.69**	**65.82**	**67.45**	**69.37**	**62.56**
	Girls.	1603	55.99	57.26	58.75	59.96	60.75	61.43	62.39	63.34	64.55	66.14	67.68	61.15
Eight	**Boys.**	**2114**	**59.32**	**60.57**	**62.14**	**63.10**	**64.00**	**64.46**	**65.76**	**66.70**	**67.73**	**69.21**	**70.23**	**64.29**
	Girls.	2044	57.80	58.91	60.28	61.32	62.27	63.19	64.18	65.03	66.10	67.69	68.79	62.62
Nine	**Boys.**	**2118**	**61.33**	**62.18**	**63.61**	**64.68**	**65.64**	**66.51**	**67.41**	**68.42**	**69.59**	**71.16**	**72.49**	**66.02**
	Girls.	1964	59.87	60.33	61.95	63.10	64.06	64.87	65.73	66.80	67.89	69.52	71.00	64.31
Ten	**Boys.**	**2000**	**62.33**	**63.68**	**65.20**	**66.60**	**67.40**	**68.31**	**69.23**	**70.23**	**71.46**	**73.41**	**75.30**	**67.87**
	Girls.	1891	59.36	60.26	61.85	63.00	63.93	66.46	67.41	68.46	69.67	71.15	72.81	65.97
Eleven	**Boys.**	**1732**	**64.03**	**65.32**	**67.13**	**68.33**	**69.28**	**70.16**	**70.92**	**71.97**	**73.36**	**75.44**	**77.25**	**69.69**
	Girls.	1643	62.35	63.26	64.91	66.16	67.38	68.45	69.61	70.48	71.61	73.84	75.81	67.90
Twelve.....	**Boys.**	**1568**	**65.44**	**66.86**	**68.66**	**69.93**	**70.91**	**71.84**	**72.97**	**73.99**	**75.32**	**77.30**	**78.96**	**71.43**
	Girls.	1628	63.64	65.31	67.29	68.50	69.55	70.61	71.77	73.11	74.81	77.14	79.23	70.42
Thirteen	**Boys.**	**1240**	**66.38**	**68.20**	**70.73**	**71.34**	**72.59**	**73.70**	**74.83**	**76.17**	**77.76**	**79.95**	**82.00**	**73.31**
	Girls.	1315	65.39	67.53	69.85	71.20	72.37	73.65	74.93	76.34	77.96	80.62	82.84	73.35
Fourteen	**Boys.**	**920**	**69.21**	**70.60**	**72.43**	**73.90**	**75.25**	**76.44**	**77.95**	**79.32**	**80.96**	**83.53**	**85.74**	**76.21**
	Girls.	1021	68.44	70.33	72.46	73.98	75.48	76.82	78.34	79.77	81.34	83.61	85 68	76.39
Fifteen.....	**Boys.**	**497**	**71.55**	**73.43**	**75.68**	**77.12**	**78.62**	**79.99**	**81.58**	**83.27**	**85.23**	**87.71**	**89.57**	**79.75**
	Girls.	660	71.19	73.08	75.17	76.69	78.26	79.07	80.64	82.71	83.84	85.87	88.25	78.95
Sixteen	**Boys.**	**206**	**72.10**	**74.65**	**78.02**	**79.75**	**81.90**	**83.60**	**84.97**	**86.65**	**88.02**	**91.06**	**93.17**	**82.59**
	Girls.	398	74.45	75.85	77.70	79.28	80.58	81.65	82.70	84.57	85.78	88.20	89.72	81.08
Seventeen	**Boys.**	**79**	**73.75**	**78.90**	**81.83**	**83.45**	**84.77**	**86.08**	**87.23**	**88.61**	**90.30**	**93.28**	**94.35**	**85.18**
	Girls.	211	75.92	77.14	79.46	80.75	81.92	83.18	84.25	85.34	87.07	89.49	91.29	82.77
Eighteen	**Boys.**	**31**	**78.10**	**84.05**	**86.20**	**88.10**	**89.10**	**89.88**	**90.52**	**91.70**	**92.70**	**93.95**	**95.45**	**88.65**
	Girls.	164	76.04	77.85	79.34	80.65	82.17	83.27	84.39	85.78	87.02	89.12	90.36	82.79
Nineteen	Girls.	82	77.02	78.05	80.04	81.00	81.73	83.20	84.03	85.06	87.12	88.95	89.98	82.30
Twenty	Girls.	65	78.75	80.12	82.00	83.25	84.83	85.79	86.83	87.50	89.00	89.81	91.75	84.99
Twenty-one ..	Girls.	32	80.60	81.40	82.70	84.20	85.26	86.33	87.40	89.20	90.40	91.40	92.40	86.97

TABLE No. 22.

The Girth of Chest at Full Expiration.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Centimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six	Boys.	679	52.00	54.06	55.12	56.09	56.92	57.60	58.35	59.24	60.12	61.85	64.20	57.26
	Girls.	743	52.36	53.46	54.97	55.90	56.91	57.48	58.28	59.15	60.28	61.84	63.64	57.00
Seven	Boys.	1715	54.09	55.10	56.36	57.28	58.15	58.92	59.77	60.65	61.83	63.74	65.55	58.68
	Girls.	1659	52.00	53.96	55.41	56.48	57.40	58.31	59.11	60.06	61.27	62.97	64.64	57.80
Eight	Boys.	2076	54.92	56.27	57.86	58.85	59.74	60.64	61.54	62.45	63.54	65.09	66.43	60.08
	Girls.	2036	54.06	55.05	56.53	57.62	58.53	59.49	60.47	61.44	62.63	64.28	65.60	59.01
Nine	Boys.	2121	56.66	57.79	59.24	60.37	61.29	62.15	63.06	64.21	65.44	67.18	68.91	61.78
	Girls.	1967	55.35	56.62	58.24	59.32	60.26	61.20	62.16	63.26	64.43	66.25	67.82	60.72
Ten	Boys.	1993	57.90	59.13	60.57	61.59	62.54	63.54	64.57	65.70	67.16	69.49	71.25	63.32
	Girls.	1894	56.33	57.71	59.34	60.55	61.51	62.47	63.48	64.61	65.92	67.79	69.92	62.07
Eleven	Boys.	1732	58.92	60.37	61.87	63.82	64.19	65.20	66.10	67.24	68.73	70.79	72.00	64.80
	Girls.	1664	57.66	58.92	60.52	61.93	63.12	64.28	65.43	66.65	67.75	69.98	71.90	63 80
Twelve.....	Boys.	1561	60.14	61.45	63.15	64.39	65.44	66.50	67.60	68.72	70.22	71.94	73.57	66.10
	Girls.	1619	59.36	61.02	62.88	64.01	65.21	66.38	67.75	69.27	70.98	73.16	75.19	66.26
Thirteen	Boys.	1215	61.52	62.78	64.46	65.82	67.14	68.33	69.48	70.58	72.00	74.51	76.28	67.92
	Girls.	1311	61.11	63.12	65.38	66.87	68.26	69.64	70.86	72.26	73.95	76.51	78.77	69.24
Fourteen	Boys.	929	63.24	64.55	66.64	67.98	69.16	70.32	71.76	73.47	75.22	77.59	79.80	70.33
	Girls.	1018	64.22	65.60	67.90	69.78	70.91	72.36	73.77	75.20	76.85	79.43	82.00	71.88
Fifteen.....	Boys.	499	65.33	67.15	69.35	70.84	72.34	73.89	74.95	76.44	78.36	80.95	83.66	73.37
	Girls.	657	66.20	68.39	70.67	72.13	73.26	74.78	76.30	77.94	80.10	82.38	84.65	74.61
Sixteen	Boys.	204	67.04	68.90	71.31	73.38	75.00	76.21	77.67	79.25	80.92	84.23	87.12	75.86
	Girls.	395	69.41	70.68	72.61	74.34	75.59	76.78	78.18	79.52	81.54	84.77	87.05	76.62
Seventeen	Boys.	80	68.00	72.33	74.33	76.00	77.44	78.33	79.33	81.50	82.67	84.00	86.00	77.61
	Girls.	201	70.68	72.51	74.16	75.74	76.98	78.27	79.76	81.12	83.00	85.36	88.00	78.01
Eighteen	Boys.	31	74.10	75.55	77.20	79.26	79.88	80.83	82.20	83.18	83.95	86.90	87.48	80.39
	Girls.	160	71.17	73.00	74.64	76.10	77.47	78.57	79.62	81.08	82.71	84.88	86.67	78.12
Nineteen	Girls.	81	68.50	70.35	71.84	73.55	74.60	76.42	77.77	78.96	80.23	82.45	85.48	75.91
Twenty	Girls.	67	70.07	70.74	73.13	74.41	75.20	76.50	77.64	79.32	80.15	82.38	82.94	76.09
Twenty-one ..	Girls.	32		70.20	73.20	74.40	75.40	76.66	77.73	79.70	80.65	84.40	86.20	76.06

TABLE No. 23.

The Girth of Chest Midway Between Full Inspiration and Full Expiration.*

Age at nearest Birthday.	Sex.	Number of Observations.	Value of Centimetres at the following Percentile Grades.										Average.
			5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six	**Boys.**	**677**	**54.02**	**55.59**	**56.92**	**57.98**	**58.64**	**59.32**	**60.04**	**60.91**	**61.93**	**63.72**	**65.62**	**59.05**
	Girls.	741	53.56	54.93	56.34	57.27	58.21	58.87	59.60	60.42	61.54	63.13	64.84	58.34
Seven	**Boys.**	**1708**	**55.91**	**57.04**	**58.31**	**59.26**	**60.31**	**60.89**	**61.73**	**62.67**	**63.82**	**65.59**	**67.46**	**60.62**
	Girls.	1631	53.99	55.61	57.08	58.22	59.07	59.87	60.75	61.70	62.91	64.55	66.16	59.47
Eight	**Boys.**	**2095**	**57.12**	**58.42**	**60.00**	**60.97**	**61.87**	**62.55**	**63.65**	**64.62**	**65.63**	**67.15**	**68.33**	**62.18**
	Girls.	2040	55 93	56.98	58.40	59.47	60.40	61.31	62.32	63.23	64.36	65.98	67.19	60.81
Nine	**Boys.**	**2120**	**58.99**	**59.98**	**61.42**	**62.52**	**63.46**	**64.33**	**65.23**	**66.31**	**67.51**	**69.17**	**70.80**	**63.90**
	Girls.	1966	57.61	58.47	60.09	61.21	62.16	63.03	63.94	65.03	66.16	67.88	69.41	62.51
Ten	**Boys.**	**1997**	**60.11**	**61.40**	**62.88**	**64.09**	**64.97**	**65.92**	**66.90**	**67.96**	**69.31**	**71.45**	**73.27**	**65.59**
	Girls.	1893	57.84	58.98	60 59	61.77	62.72	64.46	65.44	66.53	67.79	69.47	71.36	63 02
Eleven	**Boys.**	**1732**	**61.47**	**62.84**	**64.50**	**66.07**	**66.73**	**67.68**	**68.51**	**69.60**	**71.04**	**73.11**	**74.62**	**67.24**
	Girls.	1654	60.00	61.09	62.71	64.05	65.25	66.36	67.52	68.56	69.68	71.91	73.85	65.85
Twelve	**Boys.**	**1565**	**62.79**	**64.15**	**65.90**	**67.16**	**68.17**	**69.17**	**70.28**	**71.35**	**72.77**	**74.62**	**76.26**	**68.76**
	Girls.	1624	61.50	63.16	65.08	66.25	67.38	68.49	69.76	71.19	72.89	75.15	77.21	68.34
Thirteen	**Boys.**	**1228**	**63.95**	**65.49**	**67.59**	**68.58**	**69.86**	**71.01**	**72.16**	**73.37**	**74.88**	**77.23**	**79.14**	**70.61**
	Girls.	1313	63.25	65.32	67.61	69.03	70.31	71.64	72.89	74.30	75.95	78.56	80.80	71.29
Fourteen	**Boys.**	**925**	**66.22**	**67.57**	**69.53**	**70.94**	**72.20**	**73.38**	**74.85**	**76.44**	**78.09**	**80.56**	**82.77**	**73.27**
	Girls.	1020	66.33	67.96	70.18	71.88	73.19	74.59	76 05	77.48	79.09	81 52	83.84	74.13
Fifteen	**Boys.**	**498**	**68.44**	**70.29**	**72.51**	**73.98**	**75.48**	**76.94**	**78.26**	**79.85**	**81.79**	**84.33**	**86.60**	**76.56**
	Girls.	659	68.69	70.73	72.92	74.41	75.76	76.92	78.47	80.32	81.97	84.12	86.45	76.78
Sixteen	**Boys.**	**205**	**69.57**	**71.77**	**74.66**	**76.56**	**78.45**	**79.90**	**81.32**	**82.95**	**84.47**	**87.64**	**90.14**	**79.22**
	Girls.	397	71.93	73.26	75.15	76.81	78.08	79.22	80 44	82.04	83.66	86.48	88.38	78.85
Seventeen	**Boys.**	**80**	**70.87**	**75.61**	**78.08**	**79.72**	**81.10**	**82.20**	**83.28**	**85.05**	**86.48**	**88.64**	**90.17**	**81.39**
	Girls.	206	73.30	74.82	76.81	78.24	79.45	80.72	82.00	83.23	85.03	87.42	89.64	80.39
Eighteen	**Boys.**	**31**	**76.10**	**79.80**	**81.70**	**83.68**	**84.49**	**85.35**	**86.36**	**87.44**	**88.32**	**90.42**	**91.46**	**84.52**
	Girls.	162	73.60	75.42	76.99	78.37	79.82	80.92	82 00	84.93	84.86	87.00	88.51	80.45
Nineteen	Girls.	82	72.76	74.20	75.94	77.27	78.16	79.81	80.90	82.01	83.67	85.70	87.73	79.10
Twenty	Girls.	66	74.41	75.43	77.56	78.83	80.01	81.04	82.23	83.41	84.57	86.09	87.34	80.54
Twenty-one	Girls.	32		75.80	77 95	79.30	80.33	81.49	82.56	84.45	85.52	87.90	89.30	81.51

* Obtained by adding the Girth of Chest at Full Inspiration to the Girth of Chest at Full Expiration and dividing the sum by 2.

TABLE No. 24.

The Length of Head.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Millimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Millimetr's
Six	**Boys.**	**606**	**169.19**	**170.83**	**173.50**	**175.75**	**177.34**	**178.86**	**180.39**	**181.50**	**184.08**	**186.95**	**189.23**	**178.39**
	Girls.	606	163.69	166.42	169.44	170.94	172.89	174.34	175.80	177.40	178.87	180.98	183.93	173.45
Seven	**Boys.**	**1493**	**168.59**	**170.99**	**173.87**	**175.80**	**177.85**	**179.92**	**181.02**	**182.71**	**184.86**	**187.34**	**190.03**	**178.54**
	Girls.	1511	165.13	167.37	170.48	172.34	174.08	175.58	177.14	178.79	180.73	183.25	185.44	174.09
Eight	**Boys.**	**2079**	**170.03**	**171.89**	**175.14**	**176.91**	**178.80**	**180.44**	**182.03**	**183.92**	**185.81**	**188.73**	**190.86**	**179.62**
	Girls.	2125	165.55	168.42	171.07	173.26	175.25	176.41	178.17	180.15	181.48	184.18	185 90	175.18
Nine	**Boys.**	**1986**	**170.01**	**172.39**	**175.62**	**177.79**	**179.84**	**181.00**	**182.77**	**184.80**	**186.59**	**190.04**	**191.67**	**180.72**
	Girls.	1884	166.58	169.93	172.61	174.77	176.08	177.80	179.54	180.76	182.59	185.55	187.53	176.39
Ten	**Boys.**	**1912**	**171.50**	**174.37**	**177.09**	**179.10**	**180.20**	**181.51**	**183.22**	**184.99**	**186.70**	**189.85**	**191.82**	**181.45**
	Girls.	1790	167.72	170.45	173.03	175.26	176.77	178.52	180.10	181.26	183.67	185.99	188.11	177.24
Eleven	**Boys.**	**1654**	**172.66**	**175.00**	**177.70**	**179.99**	**181.38**	**182.86**	**184.62**	**186.17**	**188.34**	**190.93**	**193.38**	**182.37**
	Girls.	1560	167.47	170.73	173.69	175.73	177.82	179.75	181.00	182.71	184.84	187.45	190.35	178.08
Twelve	**Boys.**	**1576**	**172.79**	**175.22**	**178.05**	**180.32**	**181.76**	**183.08**	**184.78**	**186.41**	**188.63**	**191.85**	**194.55**	**182.84**
	Girls.	1516	169.79	172.32	175.42	177.44	179.07	180.57	182.22	183.88	185.84	189.07	191.11	179.50
Thirteen	**Boys.**	**1207**	**173.60**	**176.07**	**179.00**	**180.85**	**182.54**	**184.21**	**185.91**	**187.63**	**189.92**	**192.53**	**195.10**	**183.84**
	Girls.	1187	171.17	173.74	177.31	179.38	180.86	182.48	184.33	185.97	188.12	190.69	192.82	181.44
Fourteen	**Boys.**	**890**	**175.19**	**177.88**	**181.06**	**183.10**	**184.73**	**186.24**	**187.95**	**189.60**	**191.89**	**195.00**	**196.79**	**186.93**
	Girls.	1008	173.03	175.93	179.05	181.09	182.87	184.71	186.02	187.55	189.90	192.68	195.08	183.41
Fifteen	**Boys.**	**502**	**176.67**	**178.98**	**182.18**	**183.84**	**185.73**	**187.69**	**190.00**	**191.00**	**192.94**	**196.26**	**199.09**	**187.01**
	Girls.	649	174.49	177.46	180.59	182.47	184.33	185.67	187.67	189.46	191.34	194.32	195.98	185.12
Sixteen	**Boys.**	**191**	**178.83**	**180.48**	**183.83**	**185.74**	**188.21**	**190.04**	**191.56**	**194.01**	**195.53**	**198.48**	**200.73**	**189.06**
	Girls.	400	175.80	179.00	181.82	184.21	186.00	187.70	189.50	191.40	193.54	196.08	198.00	186.84
Seventeen	Girls.	221	179.02	181.03	183.62	185.53	187.18	188.60	190.03	191.34	193.85	197.38	199.59	188.14
Eighteen	Girls.	161	179.36	181.22	184.12	185.46	187.11	188.41	190.04	190.98	192.73	195.99	198.98	187.97
Nineteen	Girls.	77	180.70	181.85	183.80	184.92	185.97	188 31	189.30	190.70	192.80	195.65	199.06	187.91

TABLE No. 25.

The Width of Head.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Millimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Millimetr's
Six	**Boys.**	**573**	**134.70**	**138.01**	**140.08**	**141.45**	**142.73**	**143.76**	**145.11**	**146.20**	**148.01**	**150.60**	**152.72**	**143.29**
	Girls.	609	131.74	133.93	136.25	138.17	139.91	140.83	142.31	143.64	145.44	147.93	150.25	140.27
Seven	**Boys.**	**1571**	**136.31**	**138.87**	**140.80**	**142.33**	**143.46**	**144.98**	**145.93**	**147.25**	**149.26**	**151.51**	**153.54**	**144.37**
	Girls.	1505	133.66	135.56	137.64	139.61	140.80	142.10	143.25	144.74	146.13	148 78	150.70	141.40
Eight	**Boys.**	**1997**	**136.78**	**139.38**	**141.60**	**143.14**	**144.48**	**145.63**	**146.70**	**148.43**	**150.42**	**152.84**	**155.08**	**145.30**
	Girls.	1985	133.70	136.03	138.61	140.39	141.48	142.84	144.24	145.58	147.01	150.13	151.73	142.31
Nine	**Boys.**	**1962**	**137.44**	**140.04**	**141.97**	**143.62**	**145.07**	**146.08**	**147.44**	**149.20**	**150.89**	**153.56**	**155.49**	**145.87**
	Girls.	1914	134.82	136.80	139.88	141.05	142.40	143.58	144.96	146.01	148.01	150.61	152.63	143.04
Ten	**Boys.**	**1827**	**138.30**	**140.53**	**142.57**	**144.22**	**145.73**	**147.11**	**148.58**	**150.27**	**151.76**	**154.15**	**156.02**	**146.59**
	Girls.	1803	134.94	137.49	140.31	141.66	143.15	144.54	145.64	146.92	149.11	151.49	154.09	143.75
Eleven	**Boys.**	**1561**	**139.39**	**141.29**	**143.40**	**145.19**	**146.31**	**147.50**	**148.84**	**150.57**	**152.27**	**154.94**	**157.26**	**147.29**
	Girls.	1541	136.71	139.27	141.30	142.82	144.30	145.54	146.74	148.40	150.25	152.78	154.94	145.05
Twelve.....	**Boys.**	**1531**	**140.32**	**142.19**	**144.57**	**145.80**	**146.91**	**148.36**	**150.07**	**151.25**	**152.91**	**155.40**	**156.99**	**147.98**
	Girls.	1460	136.83	139.22	142.14	143.67	145.16	146.31	147.70	149.24	150.88	153.38	155.63	145.64
Thirteen	**Boys.**	**1175**	**140.41**	**142.32**	**144.88**	**146.03**	**147.48**	**149.01**	**150.68**	**152.10**	**153.85**	**156.35**	**158.79**	**148.73**
	Girls.	1167	138.49	140.40	142.61	144.26	145.76	147.15	148.53	150.22	152.12	154.82	156.79	146.78
Fourteen	**Boys.**	**873**	**141.32**	**142.78**	**145.19**	**146.88**	**148.37**	**150.04**	**151.03**	**152.40**	**154.44**	**157.47**	**160.26**	**149.50**
	Girls.	927	139.57	141.47	143.68	145.46	146.83	148.25	149.71	151.14	153.13	155.88	157.98	147.90
Fifteen	**Boys.**	**469**	**140.83**	**143.06**	**145.46**	**147.02**	**148.68**	**150.41**	**151.83**	**153.27**	**154.80**	**156.96**	**159.79**	**149.63**
	Girls.	658	140.17	141.99	144.29	146.03	147.32	148.71	150.09	151.57	153.69	156.36	158.01	148.29
Sixteen	**Boys.**	**195**	**144.22**	**145.32**	**147.00**	**148.50**	**150.25**	**151.35**	**152.65**	**154.03**	**155.88**	**157.72**	**160.71**	**150.98**
	Girls.	395	140.39	142.28	145.00	146.69	148.39	149.67	150.89	152.48	154.39	156.53	159.05	148.95
Seventeen	**Boys.**	**75**	**142.75**	**146.50**	**148.43**	**151.25**	**151.00**	**152.50**	**153.57**	**155.50**	**157.60**	**159.75**	**165.25**	**152.09**
	Girls.	221	142.12	143.39	146.25	147.72	149.03	150.43	151.71	153.44	155.31	156.81	160.24	150.04
Eighteen	Girls.	165	141.42	142.81	145.27	146.65	148.46	150.16	151.23	152.50	153.91	156.62	158.69	149.09
Nineteen	Girls.	79	140.95	141.98	145.26	146.90	148.33	150.17	151.13	153.43	154.77	156.70	159.06	149.11
Twenty	Girls.	73	139.33	142.26	144.20	145.18	146.46	147.70	149.80	151.62	152.90	155.93	159.70	147.82

TABLE No. 26.

The Height of Face from Root of Nose to Point of Chin.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Millimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Millimetr's
Six.....	**Boys.**	**604**	**82.78**	**85.54**	**88.32**	**90.15**	**91.50**	**93.20**	**95.29**	**97.94**	**100.96**	**104.83**	**107.53**	**93.72**
	Girls.	612	82.14	83.62	85.98	87.87	89.15	90.89	93.14	95.22	97.69	100.96	105.05	91.42
Seven	**Boys.**	**1580**	**85.73**	**88.23**	**90.44**	**92.12**	**93.96**	**95.57**	**97.39**	**99.86**	**102.36**	**105.83**	**109.78**	**95.87**
	Girls.	1509	83.26	85.68	88.28	90.41	91.76	93.20	95.17	96.97	99.78	103.49	106.63	93.77
Eight.....	**Boys.**	**2057**	**87.31**	**90.21**	**92.63**	**94.82**	**96.07**	**97.78**	**99.81**	**101.28**	**104.14**	**107.72**	**110.65**	**97.98**
	Girls.	2016	86.22	88.34	90.78	92.56	94.24	95.60	97.15	98.97	101.61	105.49	108.77	95.65
Nine.....	**Boys.**	**2011**	**90.06**	**91.43**	**94.14**	**95.93**	**97.60**	**99.42**	**100.77**	**103.03**	**105.46**	**109.39**	**112.35**	**99.51**
	Girls.	1898	88.60	90.42	92.63	94.59	95.97	97.60	99.43	101.04	103.58	107.42	111.22	97.85
Ten	**Boys.**	**1868**	**91.19**	**93.32**	**95.74**	**97.58**	**99.14**	**100.73**	**102.95**	**104.87**	**106.99**	**110.72**	**113.16**	**101.06**
	Girls.	1820	90.04	91.72	94.18	95.89	97.53	99.02	100.94	103.00	105.44	109.72	112.17	99.39
Eleven	**Boys.**	**1660**	**92.52**	**94.94**	**97.52**	**99.54**	**100.96**	**103.23**	**105.16**	**107.35**	**110.35**	**113.90**	**117.05**	**103.37**
	Girls.	1572	91.94	93.79	96.16	98.00	99.75	101.20	102.87	104.97	107.67	111.10	114.60	101.44
Twelve.....	**Boys.**	**1568**	**94.74**	**96.59**	**98.96**	**100.80**	**102.43**	**104.45**	**105.97**	**108.71**	**110.83**	**115.47**	**120.03**	**104.25**
	Girls.	1523	91.76	94.52	97.68	99.94	101.92	103.53	105.23	107.30	110.36	113.53	117.38	103.46
Thirteen.....	**Boys.**	**1205**	**95.58**	**97.98**	**100.61**	**102.66**	**104.86**	**106.34**	**108.71**	**110.61**	**112.91**	**116.66**	**120.70**	**106.24**
	Girls.	1231	95.70	98.15	100.66	102 54	104.21	105.71	107.85	110.19	112.21	115.60	118.59	105.92
Fourteen	**Boys.**	**893**	**96.55**	**99.70**	**102.51**	**104.77**	**106.17**	**108.51**	**110.40**	**112.35**	**115.23**	**119.43**	**123.04**	**108.43**
	Girls.	897	96.99	99.94	102.38	104.36	105.76	107.72	109.61	111.45	114.27	118.85	121.86	107.87
Fifteen.....	**Boys.**	**479**	**100.38**	**102.69**	**105.09**	**106.98**	**109.97**	**111.52**	**113.18**	**115.73**	**118.02**	**122.55**	**126.36**	**111.63**
	Girls.	672	98.24	100.68	103.31	105.80	108.07	109.40	110.96	112.75	115.34	120.24	122.74	109.79
Sixteen.....	**Boys.**	**191**	**103.31**	**105.02**	**107.89**	**110.48**	**112.49**	**113.73**	**115.62**	**117.43**	**120.52**	**123.73**	**126.96**	**113.63**
	Girls.	403	100.42	102.02	105.07	106.77	108.21	109.83	112.17	114.09	116.87	121.09	125.43	110.48
Seventeen	**Boys.**	**78**	**102.45**	**105.80**	**111.04**	**113.80**	**116.80**	**118.50**	**120.47**	**121.58**	**124.20**	**130.40**	**135.10**	**117.56**
	Girls.	223	98.79	101.66	104.40	105.82	108.24	110.50	112.59	114.18	116.74	120.18	123.85	110.04
Eighteen	Girls.	163	100.23	101.72	104.94	106.36	108.42	110.04	112.32	112.84	115.27	119.34	122.85	109.77
Nineteen.....	Girls.	80	101.00	102.17	103.75	105.60	106.75	108.34	110.20	111.80	114.00	117.00	121.00	108.72
Twenty.....	Girls.	73	102.16	103.08	105.53	107.15	109.17	110.30	111.63	112.85	115.40	120.18	121.35	110.26

TABLE No. 27.

The Width of Face.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Millimetres at the following Percentile Grades.											Average.
			5	10	20	30	40	50	60	70	80	90	95	Millimetr's
Six	**Boys.**	**608**	**105.64**	**110.25**	**112.85**	**115.23**	**116.77**	**118.20**	**119.64**	**120.74**	**122.50**	**125.44**	**127.78**	**117.24**
	Girls.	608	105.28	109.20	111.19	112.64	114.51	115.89	116.88	118.40	120.38	123.10	126.51	115.21
Seven	**Boys.**	**1637**	**108.08**	**110.83**	**113.43**	**115.38**	**116.68**	**118.40**	**119.98**	**121.04**	**122.89**	**125.59**	**128.38**	**117.78**
	Girls.	1516	107.65	110.25	112.15	113.75	115.21	116.38	117.80	119.57	120.87	123.36	126.09	116.11
Eight	**Boys.**	**2062**	**110.02**	**111.98**	**114.87**	**116.43**	**118.29**	**119.75**	**120.69**	**122.00**	**123.91**	**126.27**	**128.72**	**118.82**
	Girls.	2065	108.16	110.57	112.57	114.66	116.01	117.45	118.84	120.32	121.66	124.50	126.95	117.63
Nine	**Boys.**	**1927**	**110.05**	**112.10**	**115.49**	**117.59**	**119.70**	**120.75**	**122.14**	**123.67**	**125.51**	**128.08**	**130.62**	**119.91**
	Girls.	1905	108.20	110.62	113.55	115.63	117.17	118.81	120.24	121.36	122.99	125.59	127.83	118.02
Ten	**Boys.**	**1922**	**110.64**	**113.35**	**116.90**	**119.14**	**120.49**	**121.63**	**122.98**	**124.48**	**126.16**	**128.73**	**131.00**	**121.60**
	Girls.	1829	108.77	112.22	115.21	117.16	118.91	120.42	121.55	123.09	124.98	127.51	129.40	119.49
Eleven	**Boys.**	**1666**	**112.43**	**115.26**	**118.44**	**120.44**	**121.81**	**123.22**	**124.85**	**125.95**	**127.82**	**130.59**	**133.04**	**122.73**
	Girls.	1504	111.45	113.70	116.66	118.98	120.59	121.71	122.84	124.29	126.37	129.15	132.07	121.24
Twelve	**Boys.**	**1525**	**112.52**	**115.85**	**120.05**	**121.75**	**123.21**	**124.59**	**125.85**	**127.44**	**129.45**	**131.66**	**134.61**	**123.81**
	Girls.	1526	111.89	114.85	118.45	120.55	121.84	123.07	124.46	126.13	127.88	130.89	132.77	122.44
Thirteen	**Boys.**	**1213**	**114.96**	**118.24**	**120.96**	**122.95**	**124.63**	**126.02**	**127.38**	**128.92**	**130.65**	**133.19**	**136.40**	**125.83**
	Girls.	1248	113.10	116.40	119.71	121.53	123 38	124.86	126.28	127.87	129.76	132.35	134.78	124.15
Fourteen	**Boys.**	**898**	**116.53**	**120.13**	**122.04**	**124.30**	**125.78**	**127.32**	**128.93**	**130.63**	**132.65**	**135.39**	**137.51**	**126.81**
	Girls.	997	114.09	118.39	121.25	123.37	125.08	126.51	128.08	129.62	131.35	133.80	135.82	125.67
Fifteen.....	**Boys.**	**485**	**118.18**	**120.40**	**122.88**	**125.16**	**127.13**	**129.03**	**130.70**	**132.40**	**135.03**	**137.45**	**140.34**	**128.32**
	Girls.	678	118.57	120.75	123.63	125.39	126.86	128.30	129.66	131.08	132.96	135.88	138.41	127.85
Sixteen	**Boys.**	**193**	**120.88**	**123.29**	**125.40**	**127.38**	**129.22**	**130.82**	**132.70**	**134.01**	**135.77**	**138.78**	**140.91**	**130.27**
	Girls.	409	120.08	122.98	125.38	127.03	128.50	130.18	131.45	132.72	134.47	136.90	139.28	129.47
Seventeen	Girls.	219	122.19	123.99	126.76	128.05	130.04	131.38	132.55	134.22	135.78	138.28	140.03	130.63
Eighteen	Girls.	163	124.03	125.41	128.07	130.21	130.92	131.97	133.24	134.34	135.84	138.30	139.93	131.42

TABLE No. 28.

The Height of Face from Hair-Line to Point of Chin.

Age at Nearest Birthday.	Sex.	Number of Observations.	Value in Millimetres at the following Percentile Grades.										Average.
			5	10	20	30	40	50	60	70	80	90	95	Millimetr's
Six	Boys.	611	141.32	144.06	147.34	149.93	150.90	153.02	155.10	157.23	159.94	162.68	165.73	152.68
	Girls.	609	137.55	140.46	143.49	145.87	147.74	150.45	152.61	155.01	157.40	161.34	164.51	150.16
Seven	Boys.	1621	141.62	145.07	148.87	151.39	153.55	155.33	156.97	159.41	161.38	165.36	168.35	154.57
	Girls.	1486	141.16	144.31	147.24	150.21	152.08	154.19	155.90	158.16	160.47	163.36	165.84	153.36
Eight	Boys.	2012	144.88	148.35	151.75	154.32	156.10	158.04	160.20	161.72	164.48	168.36	170.86	157.50
	Girls	1965	143.38	146.14	150.03	152.07	153.89	155.60	157.45	160.08	162.13	165.61	168.76	155.19
Nine	Boys.	1997	146.61	150.18	153.14	155.75	158.04	160.25	162.06	164.40	166.84	170.46	173.14	159.43
	Girls.	1989	145.83	148.77	150.90	153.72	155.73	157.76	160.18	162.06	164.73	168.23	170.85	157.44
Ten	Boys.	1909	148.67	151.85	155.35	157.59	160.27	161.70	163.71	165.89	168.86	172.25	175.25	161.37
	Girls.	1835	147.07	150.37	154.28	156.43	158 49	160.56	162.57	164.90	167.40	170.85	174.37	160.04
Eleven	Boys.	1653	150.47	153.75	157.29	160.04	162.05	164.11	165.72	168.10	170.80	174.94	177.72	163.39
	Girls.	1581	149.29	152.43	156.32	158.44	161.09	163.40	165.35	168.89	170.17	173.13	176.08	162.55
Twelve	Boys.	1577	152.30	155.49	159.36	161.38	163.51	165.62	167.55	170.41	172.67	176.39	180.16	165.23
	Girls.	1510	151.83	155.14	158.77	161.77	163 45	165.95	168.41	170.34	172.46	176.61	180.06	165.29
Thirteen	Boys.	1211	154.68	157.30	161.24	163.94	165.94	168.16	170.31	172.33	175.40	178.74	181.49	167.62
	Girls.	1220	154.62	158.00	162.00	164.35	166 38	169.15	171.32	173.62	176.08	179.96	182.64	168.35
Fourteen	Boys.	896	155.98	158.90	163.66	166.35	168.65	171.04	173.56	175.98	178.86	182.59	185.95	170.49
	Girls.	998	156.99	160.43	164.85	167.19	169.73	172.00	174.68	176.91	179 64	183.01	185.77	171.38
Fifteen	Boys.	482	160.37	163.24	167.14	170.33	172.68	175.08	177.46	179.85	182.60	186.92	190.17	174.30
	Girls.	656	161.98	164.56	167.28	170.55	172.78	174.85	176.63	178.86	181.34	185.03	187.72	174.20
Sixteen	Boys.	193	165.22	168.38	171.66	173.86	175.75	177.93	180.36	183.01	185.42	191.23	194.68	178.19
	Girls.	395	163.75	166.35	170.15	172.48	174.67	176.81	179.05	181.38	184.80	188.12	190.12	176.28
Seventeen	Girls.	201	162.03	167.41	172.31	174.90	177.17	179.41	180.07	183.59	186.20	190.38	194.48	
Eighteen	Girls.	139	167.48	170.22	174.95	177.68	180.33	181.93	183.57	185.55	188.07	192.03	195.02	
Nineteen	Girls.	69	166.50	168.95	172.90	175.68	177.72	180.08	181.35	184.32	187.07	190.55	194.28	
Twenty	Girls.	72	169.30	171.60	174.08	175.52	177.16	179.00	181.07	182.88	185.87	188.90	192.20	

CHAPTER VI.

SEXUAL DIFFERENCES IN GROWTH.

When the curves of growth in weight, height standing, height sitting, span of arms and girth of chest are drawn on the same system of co-ordinates, as has been done in Plates XXV to XXIX inclusive, the attention of the observer is arrested by the extraordinary difference in the development of girls and boys during the period of prepubertal acceleration. Girls enter this time of rapid growth at age 11 or 12, two years earlier than boys, and during several years are larger than boys of the same age. The period during which girls are larger than boys does not correspond exactly with the period of accelerated development, but begins and ends a little later. The ages at which girls begin and cease to be larger than boys are given in the following table. The ages

TABLE No. 29.

AGES AT WHICH GIRLS BEGIN AND CEASE TO BE LARGER THAN BOYS.

DIMENSION.	Age at which Girls begin to be larger than Boys.			Age at which Girls cease to be larger than Boys.		
	Percentile Grades.			Percentile Grades.		
	25	50	75	25	50	75
Weight	$12\frac{6}{12}$ yrs.	$12\frac{2}{12}$ yrs.	$11\frac{6}{12}$ yrs.	$16\frac{3}{12}$ yrs.	$15\frac{6}{12}$ yrs.	$14\frac{8}{12}$ yrs.
Height standing	$11\frac{8}{12}$ "	$11\frac{5}{12}$ "	$11\frac{3}{12}$ "	$15\frac{8}{12}$ "	$15\frac{3}{12}$ "	$14\frac{6}{12}$ "
Height sitting	$11\frac{11}{12}$ "	$11\frac{6}{12}$ "	$11\frac{5}{12}$ "	$16\frac{11}{12}$ "	$16\frac{6}{12}$ "	$16\frac{2}{12}$ "
Span of arms	$12\frac{2}{12}$ "	$11\frac{11}{12}$ "	$11\frac{8}{12}$ "	$15\frac{3}{12}$ "	$14\frac{5}{12}$ "	$14\frac{2}{12}$ "
Girth of chest	$12\frac{9}{12}$ "	$12\frac{6}{12}$ "	12 "	$16\frac{3}{12}$ "	15 "	$15\frac{5}{12}$ "
Height of face from hair line to point of chin		$11\frac{9}{12}$ yrs.			15 "	

are nearly the same for the same percentile grade in all five dimensions. An examination of plates XXX to XXXVI

shows that the sexual difference just noted is not present in expansion of chest, or in strength of squeeze, or in any head or face measurement except height of face from hair-line to point of chin. Boys have therefore a larger expansion of the chest, greater strength of squeeze and greater length and width of head and height and width of face than girls throughout their period of growth.

An interesting comparison can be made of the duration of the period in which girls are larger than boys. It appears

DURATION OF THE PERIOD DURING WHICH GIRLS ARE LARGER THAN BOYS.

DIMENSION.	Percentile Grades.		
	25	50	75
Weight	$3\frac{9}{12}$ yrs.	$3\frac{4}{12}$ yrs.	$3\frac{2}{12}$ yrs.
Height standing	4 "	$3\frac{10}{12}$ "	$3\frac{3}{12}$ "
Height sitting	5 "	5 "	$4\frac{9}{12}$ "
Span of arms	$3\frac{1}{12}$ "	$2\frac{6}{12}$ "	$2\frac{0}{12}$ "
Girth of chest	$3\frac{6}{12}$ "	$2\frac{6}{12}$ "	$3\frac{5}{12}$ "

that the period is shortest in span of arms and is considerably longer in height sitting than in any other dimension.

The age at which girls begin to be larger than boys differs at different percentile grades, big girls (75 percentile grades) beginning to be larger than big boys at an earlier age than that at which small girls begin to exceed small boys. A difference is seen also in the duration of the period in which girls are larger than boys: the small girls keep their superiority during a longer time than the larger girls.

Sexual differences are further displayed in Plates XXXVII to XLI, inclusive, in which the percentile curves of both sexes are drawn one a short distance under the other, and the points at which girls begin and cease to be heavier than boys joined by heavy unbroken lines. The early superiority of large girls and the relative early loss of their superiority is seen in all the plates. The fact that the period during which big girls are larger than big boys is shorter than the period during which

little girls are larger than little boys is very clearly demonstrated by Plates XXXVIII, Height Standing, XXXIX, Height Sitting and XL, Span of Arms; it can be seen also in Plate XXXVII, Weight, and XLI, Girth of Chest, if the ninety and the five percentile grades, in which the small number of observations has probably led to error, are neglected.

CHAPTER VII.

THE RATE OF GROWTH.

The Absolute Annual Increase is the gain in weight or height, etc., during the twelve preceding months; thus, the absolute annual increase in height at age 7 is the gain in weight during the twelve months from age 6 to age 7, obtained by subtracting the average or median weight at age 6 from that at age 7.

The absolute annual increase of height standing, weight and span of arms is shown in Plate XLII and Tables No. 30, 31 and 32. In all three, the maximum for girls is at age 13 and the maximum for boys at age 15. The same may be said of the curves for height sitting, girth of chest and strength of squeeze, in Plate XLIII, from Tables No. 33, 34, 44 and 45, although the curves are less regular, owing to the observations being more difficult than those from which the preceding plate was constructed. In all six curves, the small number of observations at age 17 and 18 cause the median values at those ages to be less reliable than at other ages.

The Relative Annual Increase is the increase for any year divided by the average value at that year; thus, the relative annual increase in weight at age 7 is the difference between the average weight at age 6 and age 7 divided by the average weight at age 6. The relative annual increase gives a truer idea of growth than the absolute annual increase, because the latter value is entangled with the size of the individual measured. The absolute increase is commonly greater in a big boy than in a small boy, and yet the rate of growth may be the same. The relative annual increase is free of such errors.

The relative annual increase in strength of squeeze, weight, height standing, height sitting, span of arms and girth of chest is drawn in Plate XLIV. The gain in weight during the prepubertal acceleration is extraordinary in both girls and boys, as is the rapid fall immediately thereafter. The quickness of growth in height standing of boys is slightly greater

TABLE No. 30.

The Absolute Annual Increase in Height Standing.

Age at nearest Birthday.	Sex.	Value in Centimetres at the following Percentile Grades.											Increase in average Height.
		5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six to Seven	**Boys.**	**3.90**	**4.06**	**4.98**	**5.08**	**5.07**	**5.25**	**5.41**	**5.27**	**5.39**	**5.43**	**5.07**	**5.08**
	Girls.	4.73	4.83	4.96	5.00	5.11	5.34	5.63	5.71	5.84	5.38	5.04	5.28
Seven to Eight	**Boys.**	**4.01**	**4.72**	**4.92**	**5.20**	**5.47**	**5.30**	**5.42**	**5.59**	**5.54**	**5.49**	**5.66**	**5.10**
	Girls.	5.25	5.62	5.39	5.31	5.51	5.31	5.13	5.10	5.45	5.41	5.85	5.41
Eight to Nine	**Boys.**	**6.21**	**5.83**	**5.14**	**4.89**	**4.94**	**5.09**	**5.02**	**5.15**	**5.20**	**5.17**	**5.01**	**5.22**
	Girls.	4.99	5.26	5.27	5.39	5.36	5.36	5.37	5.12	5.35	5.18	5.63	5.31
Nine to Ten	**Boys.**	**4.15**	**3.81**	**4.29**	**4.50**	**4.60**	**4.58**	**4.73**	**4.67**	**4.89**	**5.24**	**5.39**	**4.52**
	Girls.	4.26	4.22	4.55	4.56	4.56	4.74	4.80	5.28	4.71	5.89	5.42	4.76
Ten to Eleven	**Boys.**	**4.49**	**4.67**	**4.53**	**4.55**	**4.77**	**4.99**	**4.87**	**4.70**	**4.80**	**5.04**	**5.30**	**4.97**
	Girls.	3.52	4.07	4.02	4.52	4.76	4.75	4.92	5.05	5.73	5.30	5.85	4.76
Eleven to Twelve	**Boys.**	**4.12**	**4.00**	**4.15**	**4.28**	**4.12**	**4.13**	**4.56**	**4.70**	**4.72**	**4.84**	**5.08**	**4.37**
	Girls.	5.11	5.25	5.37	5.39	5.47	5.94	6.13	6.42	6.52	7.00	7.50	5.92
Twelve to Thirteen	**Boys.**	**2.71**	**3.55**	**4.13**	**4.28**	**4.52**	**4.72**	**4.71**	**5.07**	**5.49**	**6.52**	**6.08**	**4.70**
	Girls.	6.10	6.43	6.31	6.44	6.68	6.65	6.88	7.39	7.32	6.87	6.44	7.42
Thirteen to Fourteen	**Boys.**	**5.74**	**5.49**	**4.91**	**5.05**	**5.21**	**5.57**	**5.55**	**6.25**	**6.23**	**5.64**	**6.97**	**5.67**
	Girls.	4.86	4.57	5.84	5.89	6.02	5.75	5.44	4.69	4.36	4.28	3.36	4.31
Fourteen to Fifteen	**Boys.**	**3.84**	**4.06**	**5.20**	**5.70**	**6.15**	**6.39**	**6.80**	**6.93**	**7.76**	**8.81**	**7.56**	**6.32**
	Girls.	6.09	6.54	5.14	4.67	4.03	3.88	3.19	3.23	3.29	2.46	2.84	4.20
Fifteen to Sixteen	**Boys.**	**5.48**	**5.69**	**6.43**	**6.36**	**6.80**	**6.02**	**5.61**	**5.28**	**5.07**	**3.02**	**3.11**	**5.37**
	Girls.	3.89	2.25	2.23	2.14	2.24	2.21	2.65	2.37	2.10	3.16	2.81	2.48
Sixteen to Seventeen	**Boys.**	**8.48**	**7.52**	**5.79**	**5.23**	**4.75**	**4.73**	**5.05**	**4.73**	**3.88**	**4.05**	**3.50**	**4.86**
	Girls.	1.43	2.01	1.68	1.75	1.25	1.37	1.00	1.05	1.18	0.30	0.82	1.81
Seventeen to Eighteen	**Boys.**						**4.50**						**5.28**
	Girls.	0.67	1.01	1.00	0.56	0.77	0.10	0.03	0.24	0.48	0.22	1.14	0.09

TABLE No. 31.

The Absolute Annual Increase in Weight.

Age at Nearest Birthday.	Sex.	Value in Kilogrammes at the following Percentile Grades.											Increase of Average.
		5	10	20	30	40	50	60	70	80	90	95	Kilograms.
Six to Seven.....	**Boys.**	**1.66**	**1.48**	**1.46**	**1.67**	**1.68**	**1.81**	**1.92**	**2.09**	**2.09**	**2.45**	**2.72**	**1.92**
	Girls.	1.16	1.35	1.49	1.61	1.79	1.82	1.90	2.10	2.11	2.30	2.76	1.89
Seven to Eight.....	**Boys.**	**1.32**	**1.59**	**1.83**	**1.90**	**2.07**	**2.21**	**2.36**	**2.45**	**2.54**	**2.63**	**2.65**	**2.11**
	Girls.	1.67	1.66	1.76	1.78	1.93	2.04	2.21	2.18	2.33	2.72	2.63	2.06
Eight to Nine.....	**Boys.**	**2.07**	**2.21**	**2.15**	**2.19**	**2.20**	**2.35**	**2.33**	**2.42**	**2.43**	**2.26**	**3.04**	**2.28**
	Girls.	1.62	1.79	2.01	2.09	2.08	2.19	2.22	2.46	2.56	2.52	2.86	2.20
Nine to Ten.	**Boys.**	**1.41**	**1.54**	**1.82**	**1.98**	**2.23**	**2.14**	**2.41**	**2.41**	**2.65**	**3.03**	**2.57**	**2.26**
	Girls.	1.48	1.78	1.84	2.17	2.32	2.41	2.46	2.56	2.73	2.69	2.92	2.41
Ten to Eleven.....	**Boys.**	**2.34**	**2.16**	**2.32**	**2.54**	**2.50**	**2.72**	**2.67**	**2.77**	**2.93**	**2.96**	**3.21**	**2.68**
	Girls.	1.95	2.08	2.29	2.12	2.29	2.35	2.66	2.79	2.98	4.08	4.19	2.66
Eleven to Twelve ...	**Boys.**	**2.16**	**2.22**	**2.16**	**2.14**	**2.40**	**2.33**	**2.38**	**2.63**	**2.58**	**3.07**	**3.46**	**2.51**
	Girls.	2.35	2.34	2.62	2.92	3.02	3.45	3.56	3.86	4.11	4.61	6.43	3 51
Twelve to Thirteen..	**Boys.**	**1.82**	**1.90**	**2.09**	**2.37**	**2.39**	**2.84**	**2.98**	**3.31**	**3.88**	**5.19**	**5.95**	**3.10**
	Girls.	2.96	3.18	3.65	3.97	4.37	4.75	5.31	5.82	6.10	6.51	5.47	4.83
Thirteen to Fourteen	**Boys.**	**2.73**	**3.20**	**3.56**	**3.49**	**3.68**	**3.73**	**4.61**	**5.08**	**6.37**	**5.92**	**6.58**	**3.83**
	Girls.	2.31	3.36	3.68	4.34	4.62	4.65	4.49	4.68	4.84	4.45	4.74	3.80
Fourteen to Fifteen..	**Boys.**	**3.74**	**3.38**	**3.32**	**3.94**	**4.67**	**5.51**	**5.78**	**6.19**	**6.55**	**6.79**	**6.33**	**5.78**
	Girls.	4.98	4.40	5.42	4.36	4.39	4.20	3.75	3.17	3.06	2.92	3.06	4.40
Fifteen to Sixteen...	**Boys.**	**1.96**	**2.82**	**5.53**	**5.72**	**6.34**	**6.34**	**6.67**	**6.71**	**5.66**	**6.76**	**6.87**	**5.38**
	Girls.	3.38	3.55	3.82	4.11	3.61	3.11	3.51	3.43	4.17	4.45	3.51	3.56
Sixteen to Seventeen	**Boys.**	**7.72**	**7.58**	**6.79**	**5.77**	**4.79**	**3.48**	**3.25**	**3.36**	**3.18**	**0.04**		**4.07**
	Girls.	4.41	3.57	2.15	2.08	2.43	2.56	2.72	2.53	1.48	0.84	1.66	2.36
Seventeen to Eighteen	Girls.	1.38	1.33	0.73	0.47	0.76	0.58	0.05	0.09	0.64	0.61	1.11	

TABLE No. 32.

The Absolute Annual Increase in Span of Arms.

Age at Nearest Birthday.	Sex.	Value in Centimetres at the following Percentile Grades.											Increase of Average.
		5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six to Seven.....	**Boys.**	**4.47**	**4.85**	**5.17**	**5.68**	**5.31**	**5.51**	**5.49**	**4.94**	**5.59**	**5.26**	**5.18**	**5.47**
	Girls.	4.71	4.85	4.73	4.32	4.77	6.15	5 93	6.21	5.52	5.49	5.69	5.40
Seven to Eight.....	**Boys.**	**5.05**	**5.45**	**5.43**	**5.44**	**5.55**	**5.65**	**6.03**	**5.78**	**5.91**	**6.17**	**6.31**	**5.65**
	Girls.	5.38	6.64	6.19	5.80	5.95	5 02	5.68	5.31	5.20	6.15	6.14	5.97
Eight to Nine.....	**Boys.**	**5.48**	**5.43**	**5.10**	**4.96**	**5.01**	**4.94**	**4.93**	**5.33**	**5.10**	**5.41**	**5.96**	**5.11**
	Girls.	5.08	4 00	5.40	5.50	5.28	6.15	5.37	5.43	6.35	5.16	5.85	5.30
Nine to Ten.....	**Boys.**	**3.81**	**3.97**	**4.51**	**4.76**	**4.89**	**4.94**	**5.32**	**5.49**	**5.63**	**5.82**	**5.29**	**5.04**
	Girls.	4.64	4.82	4.44	4 52	4.73	4.90	5.02	5.17	5.48	6.85	6.14	5.12
Ten to Eleven.....	**Boys.**	**4.89**	**4.62**	**4.71**	**4.71**	**4.76**	**4.98**	**5.11**	**5.16**	**5.01**	**5.01**	**5.51**	**4.91**
	Girls.	4.54	4.60	4.59	4.99	5.31	5.38	5.40	5.63	5.84	6.11	6.11	5 49
Eleven to Twelve...	**Boys.**	**4.09**	**4.23**	**4.59**	**4.71**	**4.90**	**4.89**	**4.72**	**4.71**	**5.00**	**5.51**	**5.94**	**5.47**
	Girls.	4.67	5.07	5.68	5.71	5.98	6.04	6 33	6.57	6.58	6 40	7.36	5.83
Twelve to Thirteen..	**Boys.**	**3.78**	**4.35**	**4.24**	**4.82**	**4.59**	**4.85**	**5.13**	**5.70**	**6.19**	**6.78**	**6.43**	**4.49**
	Girls.	7.50	7.15	6.79	7.17	7.29	7.23	7.75	7.44	7.23	7.08	6.19	7.12
Thirteen to Fourteen	**Boys.**	**5.88**	**5.71**	**5.97**	**5.88**	**6.20**	**6.29**	**6.68**	**5.95**	**6.03**	**6.24**	**7.70**	**6.19**
	Girls.	4.65	5.43	6.12	6.29	5.96	5.73	5.11	5.20	5.11	3.98	4.15	5.39
Fourteen to Fifteen.	**Boys.**	**2.75**	**4.30**	**5.60**	**6.02**	**6.73**	**7.17**	**7.13**	**8.00**	**9.35**	**9.97**	**10.21**	**7.15**
	Girls.	6.08	5 56	4.48	4.15	3.48	2.65	3.16	3.05	2.69	3.17	3 54	3.80
Fifteen to Sixteen...	**Boys.**	**4.86**	**4.86**	**5.98**	**6.48**	**6.53**	**6.52**	**6.67**	**5.88**	**5.03**	**3.72**	**3.02**	**5.53**
	Girls.	2.45	2.07	3.06	2.49	2.29	3.10	2.28	1.83	1.87	1.84	1.91	2.13
Sixteen to Seventeen	**Boys.**	**8.68**	**9.28**	**7.36**	**6.09**	**5.01**	**4.27**	**2.92**	**4.22**	**3.56**	**3.36**	**2.95**	**4.60**
	Girls.	1.07	0.85	0.08		0.17	0 31	0.08	0 27	0.11			0.50
Seventeen to Eighteen	**Boys.**	**11.70**	**8.60**	**6.74**	**6.00**	**5.18**	**5.92**	**6.57**	**4.37**	**4.74**	**4.55**	**2.90**	**6.75**
	Girls.	1.10	1.28	1.11	1.47	2 17	1.76	1.77	1.99	1.93	1.97	1.63	1.46

TABLE No. 33.

The Absolute Annual Increase in Height Sitting.

Age at Nearest Birthday.	Sex.	Value in Centimetres at the following Percentile Grades.											Increase in Average Height Sitting.
		5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six to Seven.....	**Boys.**	**2.13**	**2.00**	**2.01**	**2.10**	**2.25**	**2.45**	**2.46**	**2.35**	**2.05**	**2.07**	**0.61**	**2.01**
	Girls.	2.22	2.37	2.48	2.21	2.39	2.33	2.48	2.53	2.50	2.40	2.45	2.45
Seven to Eight.....	**Boys.**	**1.80**	**1.88**	**1.98**	**2.14**	**2.10**	**1.99**	**1.89**	**1.92**	**1.99**	**1.63**	**1.13**	**1.42**
	Girls.	2.81	2.35	2.11	2.15	2.21	2.52	1.94	1.70	1.92	2.13	2.07	2.17
Eight to Nine.....	**Boys.**	**1.89**	**1.78**	**1.89**	**1.76**	**1.77**	**1.87**	**2.06**	**2.13**	**2.14**	**2.16**	**2.11**	**1.99**
	Girls.	1.57	1.99	1.99	2.16	1.99	1.23	2.30	2.51	2.36	2.28	2.54	2.19
Nine to Ten.....	**Boys.**	**1.60**	**2.33**	**1.76**	**1.95**	**2.08**	**2.10**	**2.05**	**2.02**	**2.07**	**2.29**	**0.36**	**2.52**
	Girls.	1.67	1.87	1.93	1.92	2.06	2.69	2.09	2.15	2.21	2.20	2.21	2.03
Ten to Eleven	**Boys.**	**1.53**	**1.13**	**1.94**	**1.82**	**1.86**	**1.91**	**1.86**	**1.86**	**1.89**	**1.77**	**3.84**	**1.42**
	Girls.	1.69	1.41	1.04	0.86	1.83	1.74	1.71	1.88	2.02	2.29	2.35	1.84
Eleven to Twelve...	**Boys.**	**2.39**	**1.73**	**1.79**	**1.62**	**1.61**	**1.59**	**1.72**	**1.80**	**1.81**	**1.77**	**2.18**	**1.88**
	Girls.	0.91	2.19	2.98	3.08	2.50	2.60	2.79	2.90	2.78	3.16	2.72	2.64
Twelve to Thirteen..	**Boys.**	**1.06**	**1.67**	**1.37**	**1.72**	**1.74**	**1.81**	**2.19**	**1.77**	**1.92**	**2.24**	**2.19**	**1.65**
	Girls.	3.93	2.98	2.94	3.24	3.07	3 30	3.43	3.21	4.12	3.82	4.39	3.36
Thirteen to Fourteen	**Boys.**	**1.81**	**1.76**	**2.31**	**2.36**	**2.25**	**2.22**	**2.09**	**2.76**	**3.23**	**3.61**	**4.37**	**2.64**
	Girls.	1.55	2.39	2.64	2.80	2.83	3.09	2.95	3.12	2.46	2.68	2.47	2.65
Fourteen to Fifteen..	**Boys.**	**2.17**	**2.50**	**2.08**	**2.20**	**2.58**	**2.96**	**3.24**	**3.67**	**4.04**	**3.73**	**3.14**	**2.90**
	Girls.	3.80	3.22	3.38	3.14	2.98	2.59	2.53	2.45	2.25	1.81	1.77	2.74
Fifteen to Sixteen ..	**Boys.**	**2.00**	**2.09**	**2.89**	**2.83**	**3.86**	**3.55**	**3.49**	**3.08**	**2.11**	**2.56**	**2.88**	**2.54**
	Girls.	3.59	3.72	2.50	2.31	2.27	2.30	2.22	1.96	1.91	1.56	1 85	2.34
Sixteen to Seventeen	**Boys.**	**3.18**	**3.47**	**3.74**	**4.22**	**3.42**	**3.00**	**3.46**	**3.32**	**3.14**	**3.18**	**2.68**	**3.40**
	Girls.	1.51	0.85	0.52	1.16	1.12	0.91	0.86	0.90	0.67	0.99	0.75	0.90
Seventeen to Eighteen	**Boys.**		**4.26**	**2.93**	**2.10**	**1.66**	**1.48**	**1.57**	**2.47**	**3.20**	**1.66**	**0.65**	**2.55**
	Girls.	1.03	0.82	1.59	0.93	0.71	0.48	0.31	0.28	0.24		0.55	0.54

TABLE No. 34.

THE ABSOLUTE ANNUAL INCREASE IN THE GIRTH OF CHEST; DERIVED FROM TABLE NO. 23.

Age at Nearest Birthday.	Sex.	Value in Centimetres at the following Percentile Grades.											Increase of Average.
		5	10	20	30	40	50	60	70	80	90	95	Centimetr's
Six to Seven.....	**Boys.**	**1.89**	**1.45**	**1.39**	**1.28**	**1.67**	**1.57**	**1.69**	**1.76**	**1.89**	**1.87**	**1.84**	**1.57**
	Girls.	0.43		0.74	0.95	0.86	1.00	1.15	1.28	1.37	1.42	1.32	1.13
Seven to Eight.....	**Boys.**	**1.21**	**1.38**	**1.69**	**1.71**	**2.06**	**1.66**	**1.92**	**1.95**	**1.81**	**1.56**	**0.87**	**1.56**
	Girls.	2.94	1.27	1.32	1.25	1.33	1.47	1.57	1.53	1.45	1.43	1.03	1.34
Eight to Nine.....	**Boys.**	**1.87**	**1.56**	**1.42**	**1.55**	**1.09**	**1.78**	**1.58**	**1.69**	**1.88**	**2.02**	**2.47**	**1.72**
	Girls.	1.68	1.49	1.69	1.74	1.76	1.69	1.62	1.80	1.80	1.90	2.22	1.70
Nine to Ten.....	**Boys.**	**1.12**	**1.42**	**1.46**	**1.57**	**1.51**	**1.59**	**1.67**	**1.65**	**1.80**	**2.28**	**2.47**	**1.69**
	Girls.	0.23	0.51	0.50	0.56	0.56	1.43	1.50	1.50	1.63	1.59	1.95	0.51
Ten to Eleven.....	**Boys.**	**1.36**	**1.44**	**1.62**	**1.98**	**1.76**	**1.76**	**1.61**	**1.64**	**1.73**	**1.66**	**1.35**	**1.65**
	Girls.	2.16	2.11	2.12	2.28	2.53	1.90	2.08	2.03	1.89	2.44	2.49	2.83
Eleven to Twelve...	**Boys.**	**1.32**	**1.31**	**1.40**	**1.09**	**1.44**	**1.49**	**1.77**	**1.75**	**1.73**	**1.41**	**1.64**	**1.52**
	Girls.	1.50	2.07	2.37	2.20	2.13	2.13	2.24	2.63	3.21	3.24	3.36	2.49
Twelve to Thirteen.	**Boys.**	**1.16**	**1.34**	**1.69**	**1.42**	**1.69**	**1.84**	**1.88**	**1.92**	**2.11**	**2.61**	**2.88**	**1.85**
	Girls.	1.75	2.16	2.53	2.78	2.93	3.15	3.13	3.11	3.06	3.41	3.59	2.95
Thirteen to Fourteen	**Boys.**	**2.27**	**2.08**	**1.94**	**2.36**	**2.34**	**2.37**	**2.69**	**3.07**	**3.21**	**3.33**	**3.63**	**2.66**
	Girls.	3.08	2.64	2.57	2.85	2.88	2.95	3.16	3.18	3.14	2.96	3.04	2.84
Fourteen to Fifteen.	**Boys.**	**2.22**	**2.72**	**2.98**	**3.04**	**3.28**	**3.56**	**3.41**	**3.41**	**3.70**	**3.77**	**3.83**	**3.29**
	Girls.	2.36	2.77	2.74	2.53	2.57	2.33	2.42	2.84	2.88	2.60	2.61	2.65
Fifteen to Sixteen...	**Boys.**	**1.13**	**1.48**	**2.15**	**2.58**	**2.97**	**2.96**	**3.06**	**3.10**	**2.68**	**3.31**	**3.54**	**2.66**
	Girls.	3.24	2.53	2.23	2.40	2.32	2.30	1.97	1.72	1.69	2.36	1.93	2.07
Sixteen to Seventeen	**Boys.**	**1.30**	**3.84**	**3.42**	**3.16**	**2.65**	**2.30**	**1.96**	**2.10**	**2.01**	**1.00**	**0.03**	**2.17**
	Girls.	1.37	1.56	1.66	1.63	1.37	1.50	1.56	1.19	1.37	1.94	1.26	1.54
Seventeen to Eighteen	**Boys.**	**5.23**	**4.19**	**3.62**	**3.96**	**3.39**	**3.15**	**3.08**	**2.39**	**1.84**	**1.78**	**1.29**	**3.13**
	Girls.	0.30	0.60	0.18	0.13	0.37	0.20		1.70				0.06

during the years 6 and 7 than at any other time, and in girls is nearly as great in these years as in the period of acceleration. The curve of girls' height sitting is very similar to that of girls' height standing. In both, the rate of growth is more uniform than in weight. Indeed, the period of acceleration in the last named dimension is greater than in any of the others. The relative annual increase of boys' height sitting seems almost atypical, by reason of its sharp ascent at ages 8 and 9 and its failure to sink after age 16. The latter feature is perhaps due to an error in the average value caused by the small number of observations at age 17. I am unable to explain the ascent at ages 9 and 10. The growth in span of arms is somewhat more rapid at ages 7 and 8 than during the prepubertal acceleration. The curve of girls' girth of chest differs from the usual type in its sudden rise at age 11, the increase at that year appearing slightly greater than at age 13. The boys' curve, on the contrary, agrees very well with the curves of weight, height, etc., except that the curve rises at age 18, where the number of observations, it may be repeated, is perhaps too small for very sure work. The quickness with which the strength of squeeze decreases after age 7 is certainly remarkable, as is the sharpness with which the prepubertal acceleration is shown.

Attention will be called in chapter IX, to the importance in children of the relation between height and weight, girth of chest and other physical dimensions. Unusual height, it will be pointed out, is commonly a disadvantage, because it entails an unusual loss of energy. If such individuals have a weight and girth of chest, etc., so much above the common as to compensate their excessive height, they are likely to be able to meet all demands on their strength. If they do not possess this compensatory development, they will probably be unable to meet any excessive demand. Thus the question of how far this compensation exists in any individual, or, more broadly stated, the question what weight, girth of chest, etc., should accompany any given height, becomes of the greatest interest. This interest, it should be remarked, is unusually great in the case of children, for children are taxed with the

mechanical motion and other forms of dissipation of energy making up the ordinary output of life, and, in addition, with the extraordinary function of storing energy in the increase of tissue which constitutes growth.

In view of these facts, Plate XLV cannot fail to be instructive. It shows the ratio of span of arms, height sitting, chest-girth, weight, strength of squeeze with right hand, and five head and face measurements to height standing. Height standing is here expressed by an abscissa, and the percentage relation of weight and the other dimensions are displayed in curves. Of all these, span of arms most closely approximates the height, the difference being less than one per cent. of the latter from age 6 to 11 and scarcely more than 2 per cent. in subsequent ages. Span of arms in both sexes is therefore nearly the same as height standing throughout the period of observation, becoming very slightly greater than the height as growth progresses. The height sitting and the girth of chest run a parallel course and are, moreover, nearly equal, the girth of chest being about 2 per cent. less than the height sitting. They increase a little less rapidly than the height, showing a decline of about 4 per cent. in thirteen years. Height sitting and chest-girth are not far from half the height standing.

Far different is the development of weight and strength of squeeze. These increase much more rapidly than height, for at age 6 the height stands to weight in the ratio of 100 to 18 and to strength of squeeze as 100 to 6, while at age 16 these ratios are 100 to 34 and 100 to about 16, respectively. The parallelism in the development of weight and strength of squeeze is of much interest. The dimensions of head and face increase somewhat less rapidly than the height. The length of head, for example, falls from $\frac{1}{16}$th of the height, at age 6, to about $\frac{1}{11}$th at age 18.

CHAPTER VIII.

THE RELATION BETWEEN THE PHYSICAL DEVELOPMENT OF SCHOOL CHILDREN AND THEIR CAPACITY FOR MENTAL LABOR.

In Vol. VI, No. 7 of the Transactions of the Academy of Science of St. Louis, issued March 21, 1893, I demonstrated that children who possess more than the ordinary power of mental labor, as measured by their progress in their studies, are heavier, taller and larger in girth of chest and in width of head than their less gifted companions of the same age. A more extended statement of these observations was presented to the Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte, July 15, 1893, and appears in Virchow's Zeitschrift für Ethnologie under the title Untersuchungen der Schulkinder in Bezug auf die physischen Grundlagen ihrer geistigen Entwickelung. In these papers, the material was the total number of observations irrespective of the social condition of parents. An example, selected from Tables Nos. 2 and 4, page 165 and 167, of The Physical Basis of Precocity and Dullness, will illustrate the result of the inquiry. Pupils aged 11 are found in Grades I, II, III, IV, V and VI of the St. Louis Public Schools, as the following table shows. The 59 boys of Grade I, the lowest grade,

TABLE No. 35.

MEDIAN WEIGHT OF BOYS AGED 11 DISTRIBUTED BY SCHOOL GRADE.

Grades.	No. of Boys Weighed.	Median Weight.
I	59	28.83 Kg.
II	311	29.74 "
III	664	30.92 "
IV	546	31.43 "
V	123	32 41 "
VI	33	33.29 "

weigh less than the boys of Grade II, and these, again, are lighter than the boys in higher grades.

It is a well-known fact that children of the prosperous classes are better developed physically than the children of the poor. It has been suggested that the children of poor parents are not so successful in school work as the children of the rich, and that the poor children are compelled to leave school at an earlier age than the rich, and for these reasons are relatively less numerous than the rich in the higher grades. According to this idea, the better physical development of the children of the same age in the higher grades, as illustrated above in boys aged 11, is due to the preponderance in the higher grades of the well nourished children of the rich. This may be, and probably is, a factor in the phenomenon, but is surely only a partial influence.

For when children of the same age and as nearly as possible of the same social class are weighed and the weights distributed by school grade, it is found that they follow the law established for the whole material irrespective of social condition. A glance at Plate XLVI, derived from Table No. 36, will convince the reader of the truth of this statement.

TABLE No. 36.

MEDIAN WEIGHT OF THE DAUGHTERS OF MANUAL TRADESMEN DISTRIBUTED BY SCHOOL GRADE.

Age at Nearest Birthday.	Unit of Measurement and Number of Observations.	SCHOOL GRADES.							
		Kindergarten.	I.	II.	III.	IV.	V.	VI.	VII.
Seven	**Kilogr.**	**19.73**	**21.14**						
	No. of Obs.	137	187						
Eight	**Kilogr.**		**22.60**	**23.56**					
	No. of Obs.		287	136					
Nine	**Kilogr.**		**24.00**	**25.33**	**25.79**				
	No. of Obs.		87	240	68				
Ten	**Kilogr.**			**27.03**	**27.87**	**28.71**			
	No. of Obs.			152	170	33			
Eleven	**Kilogr.**			**27.97**	**29.22**	**30.11**	**29.74**		
	No. of Obs.			49	135	116	27		
Twelve	**Kilogr.**				**31.95**	**32.57**	**33.69**	**34.50**	
	No. of Obs.				65	140	76	32	
Thirteen	**Kilogr.**				**34.16**	**36.32**	**36.66**	**39.16**	**40.18**
	No. of Obs.				32	78	69	56	27
Fourteen	**Kilogr.**					**38.59**	**41.31**	**40.63**	
	No. of Obs.					25	40	60	

Further evidence is afforded by Table No. 37, in which the daughters of professional men are divided into two equal groups, in the manner explained on page 177 of The Physical Basis of Precocity and Dullness, one group containing the fifty per cent who are found in the upper grades, the other the fifty per cent found in the lower grades. It should be

TABLE No. 37.

Median Weight of the Daughters of Professional Men Distributed by School Grade.

Age at Nearest Birthday.	Number of Observations.	School Grades.	Median Weight. (Kilogram's)	Median Weight. (Kilogram's)	School Grades.	Number of Observations.	Age at Nearest Birthday.
7	50	Kg., 10 I.	20.29	20.81	90 I, II.	50	7
8	52.5	Kg., 97 I.	22.13	23.75	3 I, II, III.	52.5	8
9	53.5	I, 69 II.	24.52	25.07	31 II, III, IV, V.	53.5	9
10	57.5	I, II, 48 III.	27.19	27.64	52 III, IV, V, VI.	57.5	10
11	58.0	I, II, III, 28 IV.	28.76	31.27	72 IV, V, VI, VII.	58.0	11
12	50	I, II, III, 81 IV.	33.65	34.05	19 IV, V, VI, VII.	50	12
13	55.5	II, III, IV, 78 V.	38.46	39.55	22 V, VI, VII, VIII.	55.5	13

remarked that this method of division diminishes the conspicuousness of the difference between lower and higher grades by not presenting the weights for outlying grades, but for a small number of observations it is much more reliable than the method of which Table No. 36 is an illustration.

The results of this study of the weights of girls from the same social class distributed by school grade confirm the conclusion reached in the publications cited above, namely that successful pupils are larger than the unsuccessful.

CHAPTER IX.

THE APPLICATION TO INDIVIDUAL SCHOOL CHILDREN OF THE MEAN VALUES DERIVED FROM ANTHROPOLOGICAL MEASUREMENTS BY THE GENERALIZING METHOD.

The data for the studies described in this work can be collected either by the "generalizing" or by the "individualizing" plan. In the former, a great number of measurements is made but once on individuals of different ages, and the measurements classified according to age. In the latter, the same individuals are measured yearly or oftener during their period of growth, and the measurements classified also by age. The generalizing method, the one pursued in the present investigation, is rapidly and easily carried out, whereas the individualizing method demands for its execution exceptional opportunities and exceptional patience, requiring not only that the measurements be made and the records kept through two decades, but that the number of children measured in the early years of this long period be very great, lest death and desertion so thin the ranks that those remaining to the end shall be too few to yield trustworthy conclusions. Both methods, when applied to the same material, give identical results with regard to means, including those of subdivisions as well as those of the whole number of observations. The individualizing method does more.

The importance of the individualizing method has been much emphasized, for the reason that it can give information without which the laws derived from means cannot, in the present state of knowledge, be applied to individuals. Before this application can be made, it is necessary to know the degree of probability that an individual, who at a given age stands at a certain deviation from the mean of any dimension will show the same deviation at other ages; for example, the degree of probability that a girl whose height at age 8 is 122.06 cm., and who therefore deviates 3.7 cm., or $+1d$ from the mean of her age (118.36 cm.), will deviate to the same degree ($+1d$) from

the mean height throughout her growth. In that case, the law of growth for the type at a deviation of $+1d$ from the mean is her law of growth. Otherwise, she is an exception and practical regulations deduced from the law for the type cannot be safely made binding on her. This knowledge, as has just been said, is furnished by the individualizing method, while the generalizing method is of no assistance in this matter.

The application to individuals of the law of growth of the mean is a subject of immediate practical interest. The connection between theory and practical affairs is here unusually short and clear. Were this application possible, the deviations of children from the laws of normal growth could be quickly recognized and largely overcome, the evil effect of over study could be watched and intelligently combated, and systems of education, no longer exacting of all that which should be exacted only from the mean, could be rationally adapted to the special needs of the exceptionally weak and the exceptionally strong.

These beneficent reforms, it is at present believed, must await the slow collection of data by the individualizing method. If it is indeed true that the laws of growth determined for the mean cannot be used for the individual until the individualizing method has established the probability of each individual deviation remaining constant throughout the period of growth, then a generation must elapse — so slow is the gathering of data by this method — before the necessary knowledge is in our hands. I hope to show that this long waiting is unnecessary, and that the data collected by the generalizing method may be used, in a way hitherto unrecognized, for the making of standards by which the deviation of an individual from the mean of his age may be seen to be normal or abnormal.

Let the problem be clearly understood. The question is: this boy or girl is above or below the mean height, or weight, etc., of his or her age. How shall it be known that this deviation is normal or abnormal? There has been hitherto no satisfactory reply to this question. A vague and partial answer is possible after two measurements separated by at least a year's interval. If the deviation is the same, or very

nearly the same, at both measurements, the probability is that the child is growing normally. This probability is greater than the general probability that a normal deviation is more likely to occur than an abnormal one, but its numerical value is wholly unknown. If, on the other hand, the two deviations are unequal, the probability is that the greater of them is abnormal, but the numerical value is here also unknown. How definitely the individualizing method could answer this question is difficult of conjecture, in the present lack of data, but certainly no answer whatever could be expected except after two measurements separated by a year's interval, a year in which the unchecked cause of an abnormal deviation might inflict an irreparable damage on the organism. Such indefinite and fragmentary knowledge can never be the basis of a practical reform. Any solution of this problem which shall gain general acceptance must be easy to understand and easy to apply, and must give the probable degree of abnormality of any observed deviation. These conditions are, I believe, fulfilled by the following method.

According to the theory of probabilities, the heights of a thousand individuals of the same class will arrange themselves as follows: —

Between	M+4*d*	and	M+*nd*	3 individuals.
"	M+3*d*	"	M+4*d*	18 "
"	M+2*d*	"	M+3*d*	67 "
"	M+ *d*	"	M+2*d*	162 "
"	M	"	M+ *d*	250 "
"	M	"	M— *d*	250 "
"	M— *d*	"	M—2*d*	162 "
"	M—2*d*	"	M—3*d*	67 "
"	M—3*d*	"	M—4*d*	18 "
"	M—4*d*	"	M—*nd*	3 "

where M = the mean and *d* = the probable deviation.

Let these be divided into seven groups: —

I.	All	individuals between	M+*nd*	and	M+3*d*	21
II.	"	"	M+3*d*	"	M+2*d*	67
III.	"	"	M+2*d*	"	M+ *d*	162
VI.	"	"	M	"	M± *d*	500
V.	"	"	M— *d*	"	M—2*d*	162
IV.	"	"	M—2*d*	"	M—3*d*	67
VII.	"	"	M—3*d*	"	M—*nd*	21

The mean height, weight, girth of chest, etc., of each of these groups at any age will be the type of a certain degree of deviation from the mean of the age. That is to say, the weights, etc., of each group will be symmetrically distributed above and below the mean weight, etc., of the group in the manner already illustrated for the entire undivided number of observations, *i. e.*, the entire thousand. Each group, therefore, will be characterized by a physical development definitely determined by the means of height, weight and other physical dimensions. These means, taken together form the type or norm of the group. The individual deviations from this norm follow the theory of probability, and the degree of abnormality presented by any individual deviation can be expressed in the terms of this theory. An example will illustrate this. A boy X shows a deviation in height of $+1.5d$ from the mean height of his age. He falls therefore in Group III. The boys in this group possess a mean weight of M kilogrammes, with a probable deviation of $\pm d$; that is, boys between d and $2d$ taller than the norm of their age should weigh $M \pm d$ kilogrammes. In like manner, they should have a girth of chest of $M \pm d$ centimetres, and a span of arms of $M \pm d$ centimetres, and so on. If the weight, etc., of the boy X coincide with the means of his group (Group III) his physique is normal, the accuracy of this conclusion being proportionate to the number of different dimensions on which it is based. If the boy X deviate more than $\pm 1d$ from the mean in one or more dimensions, his development is abnormal, and the degree of abnormality is measured by the amount of his deviation.

The necessity of choosing some one dimension as the basis of such a system is self-evident. There are good reasons, partly theoretical and partly practical, why height rather than weight should be taken as a basis. Height is more stable, less liable to irrelevant fluctuations, than weight. An excess in weight can be reduced; a child whose weight is out of proportion to its height may be brought into proportion by suitable diet and exercise; but height, once attained, cannot be reduced, nor can the growth in height be easily influenced. Practically, therefore, the physical trainer must be content to bring the

weight, girth of chest, strength of squeeze and other physical dimensions up to the mean development which corresponds to the height of the child. Experience has abundantly shown that the relation of weight to height is of great importance to health, life insurance companies declining to receive applicants whose weight falls much below the standard weight of their height. For these reasons, height should be preferred as the basis of the system.

The question whether any given deviation is normal or abnormal is answered by this system in two ways: in respect of height, by the degree of deviation from the mean or norm of the whole number of observations; in respect of other dimensions, by the degree of deviation of the weight, girth of chest, etc., from the mean weight or girth of chest corresponding to the height of the individual under examination, this normal weight, etc., being determined with sufficient exactness by taking the means and probable deviations of the group in which the height falls. It is evident that all cases included within $M \pm d$ must be termed normal, for the chances are even that any individual measurement in a series will fall within $M \pm d$ and are against its exceeding these limits, being 4.64 against 1 that it will fall at $M \pm 2d$.

Strictly speaking, all abnormal deviations in any dimension are probably unhealthful, yet an important difference exists in this respect between abnormal deviations in height and abnormal deviations in weight, girth of chest, etc., as related to height. It cannot be doubted that abnormal height is probably (using the word in its technical sense) a disadvantage. The potential energy of the body is converted into mechanical labor and heat, by far the greater expenditure taking the latter form. In the adult, the total expenditure in the form of heat is about 2,700 calories in 24 hours (Helmholtz), of which 80.1 per cent escape in radiation, conduction and evaporation from the skin. Thus the superficies of the body plays a great part in the dissipation of energy. The superficies is greater, usually, in tall children than in short, a difference of special importance in the young, in whom metabolism is much more active than in the adult. More heat is therefore lost by the abnormally tall than by

those of normal height. There is a disadvantage also in the loss by mechanical labor. Greater height entails increased work on the heart and on the skeletal muscles. In short, increased loss of energy goes hand in hand with increase in height. Hence in the tall the necessity for a physical development which shall be so much above the mean as to compensate their greater loss of energy. In growing children not only must there be compensation for the expenditure of energy, but there must be also energy stored in the increase of tissue which constitutes growth.

If the greater demands of tall children are balanced by a correspondingly greater income of energy, a normal equilibrium or "health" is preserved. It should be clearly recognized that this equilibrium is unaffected by the absolute height and is dependent only on the relation between height and the other physical dimensions. Consequently health is as possible in tall children as in those of normal height, although less probable, for the chances against a compensatory development of weight and other dimensions increase very rapidly with the deviation of the height from the norm. The absolute height of an individual is of very secondary interest from a practical point of view, because it is not necessarily a state of ill health, whereas the development of weight, girth of chest, etc., in proportion to height is of supreme interest. A lack of proportion between height and other physical dimensions is itself ill health. The tendency of organisms to adopt ends to means is strong, and an imperfect compensation may suffice for most demands. A heart in which an hypertrophy of the left ventricle has partially compensated an insufficiency of the mitral valve may beat regularly enough for ordinary exertions, and yet fail utterly when its possessor is forced suddenly to ascend a height or to make any other unusual exertion. So a tall child may have a sufficient income of energy to meet the demands of a wisely regulated life, and sink under the burden of unusual tasks.

It has been shown in the foregoing pages that the means derived from anthropometrical metrical measurements by the generalizing method can be used to determine whether the

weight and other physical dimensions of an individual are normal in relation to height, and it has been pointed out that this normal relation constitutes health. It follows that the normal amount of labor cannot be exacted without injury from those in whom this equilibrium is wanting. These facts must therefore be taken into account in a rational school system, and it should now be made plain how this is to be done.

All systems of education have for their object the largest possible development of individual minds. In large schools the tasks by which this development is promoted are those which secure from the child of mean ability its maximum mental output. In practice they are determined by examinations. Hence the existence in every educational institution of classes based on the mental output of the mean pupil, and related to age only in that the output fixed as the standard of any class is necessarily found more often at a certain age than at other ages. Thus there exists a mean age for each class; the greater number of pupils at any age is found in the same class, while some have advanced beyond, and others, equally old, have not yet come so far as this class. On an average, those who have advanced beyond the greater number of their age are precocious, that is, possess more than the mean capacity for mental labor, while those who are less advanced are dull, possessing less than the mean capacity. It has been demonstrated that there is a physical basis for precocity and dullness:[1] when numbers sufficiently large for statistical purposes are employed, it is seen that precocious pupils are of greater mean weight, height, etc., than the mean pupils and that the latter are heavier and taller that the dull. The mental output is therefore directly related to the physical condition of the pupils. The mean height, weight, girth of chest, etc., in any grade is the mean physical development corresponding to the mental output of the grade. It follows that those who do not possess this development cannot without abnormal strain do the work exacted in this grade. On the other hand, pupils who possess more than the mean

[1] See Chapter VIII, page 335 *et seq.*

physical development of their age should be capable of more than the mean labor. Yet the management of this latter class presents but few difficulties, whereas the former class cannot be too carefully protected.

The consequences of continued overstrain in a growing boy or girl are most unhappy. The curves of growth in height and weight of the mean child are characteristic. The quick rise to age 7 or 8, the slower ascent to age 11 in girls and 13 in boys, the remarkable three years of accelerated development preceding puberty, and, finally, the rapid decrease in the rate of growth as full development approaches express the normal development of the type and, presumably, the normal development of the individual. Overwork may cause a temporary or a permanent deviation in these curves. It is probable, though not certain, that a temporary loss consequent on a slight overstrain may not lower the final outcome of the development, but there can be no doubt as to the result of a prolonged strain. In such a case, the probability is strong that the whole subsequent curve will be turned out of its course. A prolonged strain in a growing child harms for life and leaves a mark which can never be effaced. The danger is greatest in the periods of quickest development, particularly great in the prepubertal period. It is a sufficient commentary on the evils of the present educational methods that during these very years the undiscriminating routine of a system devised for the average pupil is most inflexibly applied to weak and strong alike.

Overstrain can often be recognized both by subjective and objective symptoms. Subjective symptoms, however, are frequently obtained with difficulty, especially in pupils who are unusually ambitious and who overstudy from choice. An objective symptom must therefore be found — a symptom easily demonstrated and almost never wanting. Such a symptom is the failure to gain weight at the normal rate. A persistent loss of weight in an adult is regarded as a matter of grave concern: the persistent failure of a child to make the normal gain in weight is no less grave. It is not pretended that the failure to gain weight always accompanies overstrain, but it is claimed that the number of exceptions is small and

that frequent weighing is the most practical and on the whole the most certain method of detecting the presence of influences that are working injury to the development of the child. The skillful breeder of cattle depends on systematic weighing to inform him if his efforts are meeting with success, but children are left to grow at haphazard.

It is not enough that overstrain should be recognized by the harm it has done. The child should be guarded against the possibility of harm. The anthropometrical system proposed offers a means of doing this. It infallibly discovers the children whose physical development is below the standard of their age. It no less certainly indicates the physical development which most often accompanies the power to do the mental work of any grade. It therefore divides the pupils into two bodies; those physically competent and those physically incompetent for a clearly defined degree of mental exertion. When working with great numbers, the infallibility of this system is practically absolute and theoretically almost absolute. When applied to individuals, errors will certainly occur, but the number of errors will according to the laws of probability be less than the number of correct conclusions, and these errors cannot influence the great fact that such a system is competent to call attention to the children who will probably be unable to do the normal work of their age without injury. Each individual case must then be treated on its own merits.

The proposed system of physical examination requires: —

I. The collection of sufficiently extensive data by the generalizing method.

II. The determination of the means and the probable deviations of height, weight, girth of chest, strength of squeeze, etc., for each age.

III. The division of the individuals at each age into groups in terms of the probable deviation from the mean height, as illustrated above, and the calculation of the mean and probable deviation of the weight, girth of chest, etc., of each group.

IV. The determination of the mean physical development of the pupils in each class or grade of the school system.

V. The physical examination of each applicant for entrance to any grade.

These data permit the enforcement of the following regulation: That no pupil whose physical development varies more than $\pm d$ from the weight, etc., of the mean pupil of his height in a class which his mental output would otherwise entitle him to enter, shall be admitted to that class, unless with the approval of a medical expert, if possible a regularly appointed school physician, who shall testify that the pupil's strength will be equal to the strain.

TABLES NO. 38 TO 51.

The tables which follow this page repeat some of the more commonly used statistical values in a form which admits of ready reference and comparison. Such are the average, probable error of the average, probable deviation, median or 50 percentile grade and median minus average values. Yet these tables are by no means summaries of the statistical calculations of the investigation, since they omit much that is given in the foregoing pages. They contain, moreover, not a little new matter. The relation of probable deviation to average, relation of average to height standing, relative annual increase of average, the 25 percentile grade, the 75 percentile grade, the cranial indices and the absolute annual increase of average of strength of squeeze and of measurements of the head and face are here presented for the first time.

Some of this material has been already discussed in this paper. Some is reserved for future discussion. One series, the relation of probable deviation to average, was treated at some length in my paper on "The relation between the growth of children and their deviation from the physical type of their sex and age," *Transactions of the Academy of Science of St. Louis*, Vol. VI, No. 10, pp. 233–250, November 14, 1893, to which the reader is referred.

Five dynamometers were used in testing the strength of squeeze; they were distinguished by the first five letters of the alphabet; A and D were graduated alike; C and E were also alike but differed from A and D, and B differed from all the others. The original values obtained with these various instruments are set down in Tables No. 45 and 46; from them were made Tables No. 43 and 44, by reducing the arbitrary graduation of all dynamometers to a uniform scale in kilogrammes.

TABLE No. 38.

The Height Standing.

Age at nearest birthday.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. *E.*	Probable Deviation *d.*	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%		%				
Six	**Boys.**	**709**	Centimetr's	**108.94**	**0.128**	**3.40**	**3.1**			**105.99**	**109.23**	**112.69**	**+0.29**
	Girls.	780		107.67	0.123	3.42	3.2			104.74	108.10	111.30	+0.43
Seven	**Boys.**	**1850**	"	**114.03**	**0.084**	**3.61**	**3.2**	**5.08**	**4.7**	**111.02**	**114.48**	**118.02**	**+0.45**
	Girls.	1791		112.95	0.089	3.75	3.3	5.28	4.9	109.72	113.44	117.07	+0.49
Eight	**Boys.**	**2223**	"	**119.13**	**0.082**	**3.89**	**3.3**	**5.10**	**4.7**	**116.08**	**119.77**	**123.58**	**+0.64**
	Girls.	2193		118.36	0.079	3.70	3.1	5.41	4.8	115.07	118.74	122.35	+0.38
Nine	**Boys.**	**2205**	"	**124.35**	**0.080**	**3.75**	**3.0**	**5.22**	**4.4**	**121.09**	**124.87**	**128.76**	**+0.52**
	Girls.	2122		123.67	0.83	3.83	3.1	5.31	4.5	120.90	124.11	127.58	+0.44
Ten	**Boys.**	**2087**	"	**128.87**	**0.087**	**3.98**	**3.1**	**4.52**	**3.6**	**125.49**	**129.45**	**133.54**	**+0.68**
	Girls.	2053		128.43	0.089	4.06	3.1	4.76	3.9	124.96	128.85	132.58	+0.42
Eleven	**Boys.**	**1819**	"	**133.84**	**0.099**	**4.23**	**3.2**	**4.97**	**3.9**	**130.03**	**134.44**	**138.29**	**+0.60**
	Girls.	1772		133.19	0.106	4.48	3.2	4.76	3.7	129.23	133.60	137.97	+0.41
Twelve	**Boys.**	**1653**	"	**138.21**	**0.116**	**4.47**	**3.2**	**4.37**	**3.3**	**134.25**	**138.57**	**142.99**	**+0.36**
	Girls.	1732		139.11	0.098	5.23	3.4	5.92	4.4	134.61	139.54	144.44	+0.43
Thirteen	**Boys.**	**1268**	"	**142.91**	**0.140**	**4.98**	**3.5**	**4.70**	**3.4**	**138.45**	**143.29**	**148.28**	**+0.38**
	Girls.	1322		146.53	0.150	5.46	3.8	7.42	5.3	140.98	146.19	151.79	−0.34
Fourteen	**Boys.**	**925**	"	**148.58**	**0.183**	**5.58**	**3.8**	**5.67**	**4.0**	**143.43**	**148.86**	**154.52**	**+0.28**
	Girls.	1085		150.84	0.156	5.15	3.7	4.31	2.9	146.85	151.94	156.32	+1.10
Fifteen	**Boys.**	**490**	"	**154.90**	**0.286**	**6.33**	**4.1**	**6.32**	**4.3**	**148.88**	**155.25**	**161.86**	**+0.35**
	Girls.	680		155.04	0.154	4.01	3.4	4.20	2.8	151.75	155.82	159.58	+0.78
Sixteen	**Boys.**	**189**	"	**160.27**	**0.427**	**5.87**	**3.7**	**5.37**	**3.5**	**155.28**	**161.27**	**167.04**	**+1.00**
	Girls.	420		157.52	0.197	4.05	2.6	2.48	1.6	153.94	158.03	161.81	+0.51
Seventeen	**Boys.**	**78**	"	**165.13**	**0.592**	**5.15**	**3.1**	**4.86**	**3.0**	**160.79**	**166.00**	**171.34**	**+0.87**
	Girls.	206		159.33	0.241	3.45	2.2	1.81	1.1	155.65	159.40	162.93	+0.07
Eighteen	**Boys.**	**29**	"	**170.41**	**0.924**	**4.98**	**2.8**	**5.28**	**3.2**		**170.50**		**+0.09**
	Girls.	164		159.42	0.265	3.39	2.1	0.09	0.06	156.40	159.50	163.29	+0.08
Nineteen	Girls.	85	"	158.46	0.438	4.04	2.6			154.32	159.56	163.27	+1.10
Twenty	Girls.	79	"	159.41	0.353	3.08	2.0				159.83		+0.42
Twenty-one	Girls.	43	"	159.98	0.651	4.27	2.7				160.50		+0.52

TABLE No. 39.

The Weight.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E	Probable Deviation d	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%	%		%				
Six	**Boys.**	**707**	Kilogram.	**19.75**	**0.054**	**1.43**	**7.2**	**18.1**			**18.57**	**19.85**	**21.27**	**+0.10**
	Girls.	798		18.93	0.051	1.44	7.6	17.6			17.70	18.99	20.44	+0.06
Seven	**Boys.**	**1814**	"	**21.67**	**0.039**	**1.68**	**7.8**	**19.0**	**1.92**	**9.7**	**20.14**	**21.66**	**23.36**	**—0.01**
	Girls.	1714		20.82	0.045	1.88	9.0	18.4	1.89	10.0	19.25	20.81	22.55	—0.01
Eight	**Boys.**	**2188**	"	**23.78**	**0.042**	**1.96**	**8.2**	**20.0**	**2.11**	**9.7**	**22.00**	**23.87**	**25.85**	**+0.09**
	Girls.	2147		22.88	0.042	1.95	8.5	19.3	2.06	9.9	21.02	22.85	24.75	—0.03
Nine	**Boys.**	**2188**	"	**26.06**	**0.045**	**2.09**	**8.0**	**21.0**	**2.28**	**9.6**	**24.17**	**26.22**	**28.28**	**+0.16**
	Girls.	2055		25.08	0.049	2.23	8.9	20.3	2.20	9.6	23.07	25.04	27.31	—0.04
Ten	**Boys.**	**2064**	"	**28.32**	**0.049**	**2.23**	**7.9**	**22.0**	**2.26**	**8.7**	**26.07**	**28.36**	**30.81**	**+0.04**
	Girls.	1947		27.49	0.052	2.31	8.4	21.4	2.41	9.6	25.08	27.45	29.96	—0.04
Eleven	**Boys.**	**1743**	"	**31.00**	**0.062**	**2.60**	**8.4**	**23.2**	**2.68**	**9.5**	**28.50**	**31.08**	**33.66**	**+0.08**
	Girls.	1708		30.15	0.070	2.91	9.6	22.6	2.66	9.7	27.28	29.80	32.84	—0.35
Twelve.....	**Boys.**	**1644**	"	**33.51**	**0.061**	**2.46**	**7.3**	**24.2**	**2.51**	**8.1**	**30.65**	**33.41**	**36.26**	**—0.10**
	Girls.	1676		33.66	0.081	3.31	9.8	24.2	3.51	11.6	30.05	33.25	36.83	—0.41
Thirteen	**Boys.**	**1242**	"	**36.61**	**0.110**	**3.88**	**10.6**	**25.6**	**3.10**	**9.3**	**32.88**	**36.25**	**39.86**	**—0.36**
	Girls.	1343		38.49	0.115	4.22	11.0	26.3	4.83	14.3	33.86	38.00	42.79	—0.49
Fourteen	**Boys.**	**946**	"	**40.44**	**0.148**	**4.56**	**11.3**	**27.2**	**3.83**	**10.5**	**36.41**	**39.98**	**45.38**	**—0.46**
	Girls.	1082		42.29	0.142	4.67	11.0	28.0	3.80	9.9	37.87	42.65	47.55	+0.36
Fifteen	**Boys.**	**498**	"	**46.22**	**0.227**	**5.06**	**11.0**	**29.8**	**5.78**	**14.3**	**40.04**	**45.49**	**51.75**	**—0.73**
	Girls.	690		46.69	0.154	4.05	8.7	30.1	4.40	10.4	42.59	46.85	50.66	+0.16
Sixteen	**Boys.**	**203**	"	**51.60**	**0.431**	**6.16**	**12.0**	**32.0**	**5.38**	**11.6**	**45.66**	**51.83**	**57.99**	**+0.23**
	Girls.	420		50.25	0.207	4.24	8.4	31.9	3.56	7.6	46.56	49.96	54.96	—0.29
Seventeen	**Boys.**	**71**	"	**55.67**	**0.521**	**4.38**	**7.9**	**33.7**	**4.07**	**7.9**	**51.94**	**55.31**	**61.21**	**—0.36**
	Girls.	230		52.61	0.244	3.70	7.0	33.0	2.36	4.7	48.67	52.52	56.47	—0.09
Eighteen	Girls.	155	"	52.36	0.289	3.60	6.9	33.0			49.27	53.10	56.83	+0.74
Nineteen	Girls.	81	"	52.19	0.332	3.76	7.2	32.8			48.93	52.47	55.74	+0.28
Twenty	Girls.	66	"	53.91	0.565	3.76	7.0	33.7			50.01	53.57	57.33	—0.34

TABLE No. 40.

The Height Sitting.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E.	Probable Deviation d.	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%	%		%				
Six	**Boys.**	**714**	Centimetr's	**61.31**	**0.105**	**2.82**	**4.6**	**56.3**			**59.11**	**60.77**	**63.02**	**−0.54**
	Girls.	751		59.45	0.132	2.03	3.4	55.2			58.23	60.11	62.05	+0.66
Seven	**Boys.**	**1853**	"	**63.32**	**0.061**	**2.64**	**4.2**	**55.5**	**2.01**	**3.3**	**61.16**	**63.22**	**65.22**	**−0.10**
	Girls.	1727		61.80	0.053	2.19	3.5	54.7	2.45	4.1	60.58	62.44	64.56	+0.64
Eight	**Boys.**	**2239**	"	**64.74**	**0.048**	**2.26**	**3.5**	**54.4**	**1.42**	**2.2**	**63.22**	**65.21**	**67.17**	**+0.47**
	Girls.	2120		63.97	0.044	2.04	3.2	54.0	2.17	3.5	62.71	64.96	66.37	+0.99
Nine	**Boys.**	**2258**	"	**66.73**	**0.049**	**2.34**	**3.5**	**53.7**	**1.99**	**3.1**	**65.05**	**67.08**	**69.32**	**+0.35**
	Girls.	2071		66.16	0.046	2.11	3.2	53.5	2.19	3.4	64.78	66.19	68.82	+0.03
Ten	**Boys.**	**2118**	"	**69.25**	**0.040**	**2.42**	**3.5**	**53.7**	**2.52**	**3.8**	**66.90**	**69.18**	**71.35**	**−0.07**
	Girls.	2037		68.19	0.049	2.19	3.2	53.1	2.03	3.1	66.72	68.88	70.99	+0.69
Eleven	**Boys.**	**1828**	"	**70.67**	**0.060**	**2.56**	**3.6**	**52.8**	**1.42**	**2.1**	**68.78**	**71.09**	**73.23**	**+0.42**
	Girls.	1748		70.03	0.057	2.37	3.4	52.6	1.84	2.7	67.96	70.62	72.94	+0.59
Twelve	**Boys.**	**1656**	"	**72.55**	**0.067**	**2.72**	**3.8**	**52.5**	**1.88**	**2.7**	**70.49**	**72.68**	**75.03**	**+0.13**
	Girls.	1707		72.67	0.063	2.61	3.6	52.2	2.64	3.8	70.69	73.22	75.78	+0.55
Thirteen	**Boys.**	**1285**	"	**74.20**	**0.076**	**2.74**	**3.7**	**51.9**	**1.65**	**2.3**	**72.03**	**74.49**	**76.88**	**+0.29**
	Girls.	1354		76.03	0.078	2.87	3.8	51.9	3.36	4.6	73.78	76.52	79.44	+0.49
Fourteen	**Boys.**	**936**	"	**76.84**	**0.103**	**3.15**	**4.1**	**51.7**	**2.64**	**3.6**	**74.37**	**76.71**	**79.87**	**−0.13**
	Girls.	1065		78.68	0.095	3.11	4.0	52.2	2.65	3.5	76.50	79.61	82.23	+0.93
Fifteen	**Boys.**	**498**	"	**79.74**	**0.161**	**3.59**	**4.5**	**51.5**	**2.90**	**3.8**	**76.51**	**79.67**	**83.73**	**−0.07**
	Girls.	674		81.42	0.098	2.54	3.1	52.5	2.74	3.5	79.76	82.20	84.58	+0.78
Sixteen	**Boys.**	**193**	"	**82.28**	**0.250**	**3.48**	**4.2**	**51.3**	**2.54**	**3.2**	**79.37**	**83.22**	**86.32**	**+0.94**
	Girls.	411		83.76	0.116	2.36	2.8	53.2	2.34	2.9	82.16	84.50	86.52	+0.74
Seventeen	**Boys.**	**77**	"	**85.68**	**0.427**	**3.77**	**4.4**	**51.9**	**3.40**	**4.1**	**83.35**	**86.62**	**89.55**	**+0.94**
	Girls.	202		84.66	0.153	2.17	2.6	53.2	0.90	1.1	83.00	85.41	87.30	+0.75
Eighteen	**Boys.**	**31**	"	**88.23**	**0.536**	**2.89**	**3.3**	**51.7**	**2.55**	**3.1**	**85.86**	**87.70**	**92.39**	**−0.53**
	Girls.	167		85.20	0.133	1.72	2.0	53.7	0.54	0.6	84.26	85.89	87.56	+0.69
Nineteen	Girls.	85		84.86	0.198	1.82	2.1	53.3			83.96	85.68	87.27	+0.82
Twenty	Girls.	78		85.31	0.230	2.03	2.4	53.3			84.15	86.00	88.08	+0.69
Twenty-one	Girls.	41		85.05	0.290	1.86	2.2					85.79		+0.74

TABLE No. 41.

THE SPAN OF ARMS.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E.	Probable Deviation d.	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%	%		%				
Six	**Boys.**	**708**	Centimetre.	**108.95**	**1.044**	**3.85**	**3.5**	**100.0**			**105.66**	**109.57**	**113.60**	**+0.62**
	Girls.	769		106.96	0.140	3.87	3.6	99.4			104.18	107.29	111.41	+0.33
Seven	**Boys.**	**1862**	"	**114.42**	**0.096**	**4.16**	**3.6**	**100.3**	**5.47**	**5.0**	**111.09**	**115.08**	**118.87**	**+0.66**
	Girls.	1724		112.36	0.107	4.18	3.7	99.5	5.40	5.0	108.76	113.11	117.27	+0.75
Eight	**Boys.**	**2234**	"	**120.07**	**0.088**	**4.18**	**3.5**	**100.8**	**5.65**	**4.9**	**116.52**	**120.73**	**124.71**	**+0.66**
	Girls.	2152		118.33	0.092	4.28	3.6	100.0	5.97	5.3	114.70	118.13	122.53	−0.20
Nine	**Boys.**	**2272**	"	**125.18**	**0.089**	**4.25**	**3.4**	**100.7**	**5.11**	**4.3**	**121.55**	**125.67**	**129.93**	**+0.49**
	Girls.	2065		123.63	0.092	4.18	3.4	100.0	5.30	4.5	120.15	124.28	128.42	+0.65
Ten	**Boys.**	**2076**	"	**130.22**	**0.103**	**4.70**	**3.6**	**101.0**	**5.04**	**4.0**	**126.19**	**130.61**	**135.49**	**+0.39**
	Girls.	2045		128.75	0.104	4.69	3.6	100.2	5.12	4.1	124.63	129.18	133.74	+0.43
Eleven	**Boys.**	**1810**	"	**135.13**	**0.113**	**4.84**	**3.6**	**100.9**	**4.91**	**3.8**	**130.89**	**135.59**	**140.57**	**+0.46**
	Girls.	1757		134.24	0.116	4.87	3.6	100.8	5.49	4.3	129.42	134.56	139.48	+0.22
Twelve	**Boys.**	**1664**	"	**140.60**	**0.112**	**4.57**	**3.2**	**101.7**	**5.47**	**4.1**	**135.55**	**140.48**	**145.43**	**−0.12**
	Girls.	1718		140.07	0.109	4.51	3.2	100.7	5.83	4.3	135.12	140.60	146.05	+0.53
Thirteen	**Boys.**	**1281**	"	**145.09**	**0.159**	**5.71**	**3.9**	**101.5**	**4.49**	**3.2**	**140.08**	**145.33**	**151.37**	**+0.24**
	Girls.	1368		147.19	0.150	5.55	3.8	100.5	7.12	5.1	142.10	147.83	153.39	+0.64
Fourteen	**Boys.**	**934**	"	**151.28**	**0.197**	**6.03**	**4.0**	**101.8**	**6.19**	**4.3**	**146.00**	**151.62**	**157.36**	**+0.34**
	Girls.	1088		152.58	0.160	5.29	3.5	101.2	5.39	3.7	148.30	153.56	158.54	+0.98
Fifteen	**Boys.**	**495**	"	**158.43**	**0.321**	**7.15**	**4.5**	**102.3**	**7.15**	**4.7**	**151.81**	**158.79**	**166.04**	**+0.36**
	Girls.	677		156.38	0.176	4.58	2.9	100.9	3.80	2.5	152.62	156.21	161.41	−0.17
Sixteen	**Boys.**	**189**	"	**163.96**	**0.574**	**7.89**	**4.8**	**102.3**	**5.53**	**3.5**	**158.04**	**165.31**	**171.49**	**+1.35**
	Girls.	413		158.51	0.217	4.41	2.8	100.7	2.13	1.4	155.39	159.31	163.26	+0.80
Seventeen	**Boys.**	**75**	"	**168.56**	**0.581**	**5.03**	**3.0**	**102.1**	**4.60**	**2.8**	**164.77**	**169.58**	**175.38**	**+1.02**
	Girls.	202		159.01	0.285	4.05	2.5	102.1	0.50	3.2	155.36	159.62	163.45	+0.61
Eighteen	**Boys.**	**32**	"	**175.31**	**0.761**	**4.31**	**2.5**	**102.9**	**6.75**	**4.0**	**171.14**	**175.50**	**179.94**	**+0.19**
	Girls.	164		160.47	0.334	4.28	2.7	101.3	1.46	0.9	156.65	161.38	165.41	+0.91
Nineteen	Girls.	83	"	158.45	0.517	4.71	2.9	101.8			155.17	158.90	163.09	+0.45
Twenty	Girls.	76	"	160.17	0.474	4.13	2.6	100.1			156.45	161.50	164.98	+1.33
Twenty-one	Girls.	37	"	161.27	0.712	4.33	2.7	100.1			157.40	160.88	166.68	−0.39

TABLE No. 42.

The Girth of Chest Midway Between Inspiration and Expiration.*

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. *E.*	Probable Deviation *d.*	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%	%		%				
Six	**Boys.**	**677**	Centimetre.	**59.05**	**0.083**	**2.22**	**3.8**	**54.2**			**57.45**	**59.32**	**61.42**	**+0.27**
	Girls.	741		58.34	0.091	2.48	4.3	54.2			56.81	58.87	60.98	+0.53
Seven	**Boys.**	**1708**	"	**60.62**	**0.057**	**2.38**	**3.9**	**53.1**	**1.57**	**2.7**	**58.79**	**60.89**	**63.25**	**+0.63**
	Girls.	1631		59.47	0.062	2.47	4.2	52.7	1.13	1 9	57.65	59.87	62.31	+0.40
Eight	**Boys.**	**2095**	"	**62.18**	**0.052**	**2.35**	**3.8**	**52.2**	**1.56**	**2.6**	**60.49**	**62.55**	**65.13**	**+0.37**
	Girls.	2040		60.81	0.053	2.40	3.9	51.3	1.34	2.3	58.94	61.34	63.80	+0.53
Nine	**Boys.**	**2120**	"	**63.90**	**0.055**	**2.51**	**3.9**	**51.4**	**1.72**	**2.8**	**61.97**	**64.33**	**66.91**	**+0.43**
	Girls.	1966		62.51	0.057	2.53	4.0	50.6	1.70	2.8	60.65	63.03	65.60	+0.52
Ten	**Boys.**	**1997**	"	**65.59**	**0.061**	**2.72**	**4.1**	**50.9**	**1.69**	**2.6**	**63.49**	**65.92**	**68.64**	**+0.33**
	Girls.	1893		63.02	0.061	2.67	4.2	49.1	0.51	0.8	61.18	64.46	67.16	+0.45
Eleven	**Boys.**	**1732**	"	**67.24**	**0.063**	**2.61**	**3.9**	**50.2**	**1.65**	**2.5**	**65.29**	**67.68**	**70.32**	**+0.44**
	Girls.	1654		65.85	0.075	3.04	4.6	49.4	2.83	4.5	63.38	66.36	69.12	+0.52
Twelve	**Boys.**	**1565**	"	**68.76**	**0.074**	**2.94**	**4.3**	**49.8**	**1.52**	**2.3**	**66.53**	**69.17**	**72.06**	**+0.41**
	Girls.	1624		68.34	0.081	3.24	4.7	49.1	2.49	3.8	65.67	68.49	72.04	+0.16
Thirteen	**Boys.**	**1228**	"	**70.61**	**0.089**	**3.11**	**4.4**	**49.4**	**1.85**	**2.7**	**68.09**	**71.01**	**74.13**	**+0.40**
	Girls.	1313		71.29	0.098	3.54	5.0	48.6	2.95	4.3	68.32	71.64	75.13	+0.35
Fourteen	**Boys.**	**925**	"	**73.27**	**0.118**	**3.58**	**4.9**	**49.3**	**2.66**	**3.8**	**70.24**	**73.38**	**77.27**	**+0.11**
	Girls.	1020		74.13	0.114	3.65	4.9	49.5	2.84	4.0	71.03	74.59	78.29	+0.46
Fifteen	**Boys.**	**498**	"	**76.56**	**0.169**	**3.77**	**4.9**	**49.4**	**3.29**	**4.5**	**73.25**	**76.94**	**80.82**	**+0.38**
	Girls.	659		76.78	0.143	3.70	4.7	50.1	2.65	3.6	73.67	76.92	81.15	+0.15
Sixteen	**Boys.**	**205**	"	**79.22**	**0.293**	**4.19**	**5.3**	**49.4**	**2.66**	**3.5**	**75.61**	**79.90**	**83.71**	**+0.68**
	Girls.	397		78.85	0.164	3.27	4.1	50.5	2.07	2.7	75.98	79.22	82.85	+0.37
Seventeen	**Boys.**	**80**	"	**81.39**	**0.353**	**3.15**	**3.9**	**49.3**	**2.17**	**2.7**	**78.90**	**82.20**	**85.77**	**+0.81**
	Girls.	206		80.39	0.233	3.34	4.2	50.8	1.54	2.0	77.53	80.72	84.13	+0.34
Eighteen	**Boys.**	**31**	"	**84.52**	**0.528**	**2.94**	**3.5**	**49.6**	**3.13**	**3.8**	**82.69**	**85.35**	**88.38**	**+0.83**
	Girls.	162		80.45	0.254	3.23	4.0	49.7	0.06	0.1	77.68	80.92	84.90	+0.47
Nineteen	Girls.	82	"	79.10	0.380	3.43	4.3	50.3			76.61	79.81	82.84	+0.71
Twenty	Girls.	66	"	80.54	0.339	2.76	3.4				78.20	81.04	83.99	+0.61
Twenty-one	Girls.	32	"	81.51	0.521	2.82	3.5				78.63	81.49	84.99	—0.03

* Obtained by adding the Girth of Chest at full Inspiration to the Girth of Chest at full Expiration and dividing by 2.

TABLE No. 43.

THE STRENGTH OF SQUEEZE, RIGHT HAND.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E.	Probable Deviation d.	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	Median or 50 Percentile Grade.	Median Minus Average.
					±	±	%	%		%		
Six	**Boys.**	**626**	Kilogram.	**6.09**	**0.056**	**1.41**	**23.2**	**5.6**			**6.30**	**+0.21**
	Girls.	687		5.14	0.053	1.39	27.0	4.8			5.93	+0.79
Seven	**Boys.**	**1551**	"	**7.69**	**0.039**	**1.52**	**19.8**	**6.7**	**1.60**	**26.2**	**7.67**	**—0.02**
	Girls.	1493		6.53	0.043	1.67	25.6	5.8	1.39	27.0	6.56	+0.03
Eight	**Boys.**	**1880**	"	**9.38**	**0.045**	**1.95**	**20.8**	**7.9**	**1.69**	**22.0**	**9.59**	**+0.21**
	Girls.	1873		8.11	0.043	1.87	23.1	6.9	1.58	24.2	8.24	+0.13
Nine	**Boys.**	**2002**	"	**11.35**	**0.055**	**2.45**	**21.6**	**9.1**	**1.97**	**21.0**	**10.65**	**—0.70**
	Girls.	1829		9.23	0.049	2.11	22.9	7.5	1.12	13.8	9.14	—0.09
Ten	**Boys.**	**1878**	"	**12.83**	**0.061**	**2.66**	**20.7**	**10.0**	**1.48**	**13.0**	**12.72**	**—0.11**
	Girls.	1801		10.42	0.053	2.27	21.9	8.1	1.19	12.9	10.36	—0.06
Eleven	**Boys.**	**1644**	"	**14.37**	**0 068**	**2.74**	**19.1**	**10.7**	**1.54**	**12.0**	**14.29**	**—0.08**
	Girls.	1613		11.80	0.060	2.42	20.5	8.9	1.36	13.1	12.07	+0.27
Twelve	**Boys.**	**1506**	"	**16.70**	**0.082**	**3.17**	**18.8**	**12.1**	**2.33**	**16.2**	**16.56**	**—0.14**
	Girls.	1553		13.46	0.072	2.83	21.0	9.7	1.66	14.1	13.39	—0.07
Thirteen	**Boys.**	**1152**	"	**19.08**	**0.126**	**4.27**	**22.4**	**13.3**	**2.38**	**14.2**	**18.99**	**—0.09**
	Girls.	1256		16.13	0.093	3.31	20.5	11.0	2.67	19.8	15.51	—0.62
Fourteen	**Boys.**	**848**	"	**22.32**	**0.143**	**4.15**	**18.6**	**15.0**	**3.24**	**17.0**	**21.82**	**—0.50**
	Girls.	950		18.02	0.133	4.11	22.8	12.0	1.89	11.7	17.78	—0.24
Fifteen	**Boys.**	**447**	"	**26.69**	**0.244**	**5.10**	**19.1**	**17.2**	**4.37**	**19.6**	**26.17**	**—0.52**
	Girls.	617		20.01	0.147	3.65	18.2	12.9	1.99	11.0	20.32	+0.31
Sixteen	**Boys.**	**163**	"	**31.04**	**0.414**	**5.29**	**17.0**	**19.4**	**4.35**	**16.3**	**29.90**	**—1.14**
	Girls.	356		21.78	0.200	3.77	17.3	13.8	1.77	8.8	21.60	—0.18
Seventeen	**Boys.**	**21**	"		**0.458**						**30.70**	
	Girls.	112		21.88				13.7	0.10	4.6	22.25	+0.37
Eighteen	Girls.	75	"	24.13				15.2	2.25	10.0	24.88	+0.75
Nineteen	Girls.	53	"	21.82				13.7			22.25	+0.43
Twenty	Girls.	61	"	22.92				14.3			22.81	—0.11
Twenty-one	Girls.	38	"								24.00	

TABLE No. 44.

The Strength of Squeeze, Left Hand.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. *E.*	Probable Deviation *d.*	Relation of Probable Deviation to Av'age. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	Median or 50 Percentile Grade.	Median Minus Average.
					±	±	%	%		%		
Six	**Boys.**	**629**	Kilogram.	**5.59**	**0.057**	**1.43**	**25.6**	**5.1**			**6.12**	**+0.53**
	Girls.	686		4.77	0.056	1.47	30.8	4.4			5.46	+0.69
Seven	**Boys.**	**1550**	"	**7.15**	**0.044**	**1.72**	**24.1**	**6.3**	**1.56**	**27.9**	**7.11**	**—0.04**
	Girls.	1488		5.70	0.042	1.62	28.4	5.1	0.97	20.3	6.24	+0.54
Eight	**Boys.**	**1882**	"	**8.76**	**0.048**	**2.08**	**23.2**	**7.4**	**1.61**	**22.5**	**8.74**	**—0.02**
	Girls.	1882		7.52	0.046	2.00	26.6	6.4	1.82	31.9	7.30	—0.22
Nine	**Boys.**	**2007**	"	**10.43**	**0.059**	**2.66**	**25.5**	**8.4**	**1.67**	**19.1**	**10.24**	**—0.19**
	Girls.	1828		8.47	0.049	2.10	24.8	6.9	0.95	12.6	8.29	—0.18
Ten	**Boys.**	**1886**	"	**11.72**	**0.059**	**2.57**	**21.9**	**9.1**	**1.29**	**12.4**	**11.59**	**—0.13**
	Girls.	1798		9.38	0.053	2.23	23.8	7.3	0.91	10.7	9.97	—0.59
Eleven	**Boys.**	**1650**	"	**13.49**	**0.067**	**2.70**	**20.0**	**10.1**	**1.77**	**15.1**	**13.26**	**—0.23**
	Girls.	1616		11.07	0.059	2.36	21.3	8.3	1.69	18.0	11.09	+0.02
Twelve	**Boys.**	**1502**	"	**15.37**	**0.080**	**3.11**	**20.2**	**11.1**	**1.88**	**13.9**	**15.08**	**—0.29**
	Girls.	1554		12.60	0.076	2.98	23.7	9.1	1.53	13.8	12.65	+0.05
Thirteen	**Boys.**	**1148**	"	**17.31**	**0.103**	**3.50**	**20.2**	**12.1**	**1.94**	**12.6**	**16.95**	**—0.36**
	Girls.	1257		14.83	0.094	3.35	22.6	10.1	2.23	17.7	14.71	—0.12
Fourteen	**Boys.**	**854**	"	**20.27**	**0.134**	**3.93**	**19.4**	**13.6**	**2.96**	**17.5**	**19.77**	**—0.50**
	Girls.	947		17.13	0.127	3.90	22.7	11.4	2.30	15.5	16.44	—0.69
Fifteen	**Boys.**	**439**	"	**23.94**	**0.243**	**5.10**	**21.3**	**15.4**	**3.67**	**18.1**	**24.04**	**+0.08**
	Girls.	618		18.23	0.154	3.84	21.1	11.8	1.10	6.4	18.64	+0.41
Sixteen	**Boys.**	**162**	"	**27.25**	**0.438**	**5.58**	**20.5**	**17.0**	**3.31**	**13.8**	**27.79**	**+0.54**
	Girls.	359		19.86	0.207	3.93	19.8	12.6	1.63	8.9	19.78	—0.08
Seventeen	**Boys.**	**58**	"	**29.58**	**0.639**	**4.87**	**16.5**	**17.9**	**2.33**	**8.6**	**30.18**	**+0.60**
	Girls.	144		20.10	0.264	3.17	15.8	12.6	0.24	12.1	20.00	—0.10
Eighteen	Girls.	75	"	23.48				14.8	3.38	16.8	23.50	+0.02
Nineteen	Girls.	53	"	20.79				13.1			21.17	+0.38
Twenty	Girls.	62	"	22.19				13.9			22.67	+0.48
Twenty-one	Girls.	38	"	23.28							23.00	—0.28

TABLE No. 45.

The Strength of Squeeze, Right Hand.

AGE AT NEAREST BIRTHDAY.	Sex.	Unit of Measurement.	Dynamometers A. & D.				Dynamometer B.				Dynamometers C. & E.			
			No. of Observations.	Average.	Median.	Probable Deviation	No. of Observations.	Average.	Median.	Probable Deviation	No. of Observations.	Average.	Median.	Probable Deviation
Six.....	**Boys.**	Kilogram.	**159**	**5.25**	**5.74**	**1.24**	**198**	**10.25**	**10.61**	**2.04**	**269**	**16.03**	**15.82**	**4.08**
	Girls.		197	4.25	5.32	1.29	201	8.68	9.53	2.21	289	13.91	15.80	3.60
Seven.....	**Boys.**	"	**436**	**7.26**	**7.24**	**1.86**	**427**	**12.29**	**11.85**	**1.32**	**688**	**19.67**	**20.24**	**4.52**
	Girls.		377	6.35	6.49	1.85	395	10.18	10.62	2.11	721	16.64	15.88	4.47
Eight.....	**Boys.**	"	**744**	**9.85**	**10.21**	**2.47**	**377**	**14.15**	**14.70**	**2.84**	**759**	**22.87**	**22.72**	**4.44**
	Girls.		746	8.15	8.57	2.41	393	12.22	12.30	2.57	734	20.67	20.53	3.85
Nine.....	**Boys.**	"	**877**	**12.29**	**11.25**	**3.10**	**351**	**16.47**	**15.95**	**3.33**	**774**	**27.77**	**26.00**	**5.25**
	Girls.		829	9.39	9.28	2.70	328	13.33	13.33	2.92	672	24.17	23.78	5.62
Ten.....	**Boys.**	"	**941**	**13.65**	**12.89**	**3.23**	**363**	**18.94**	**20.02**	**3.57**	**574**	**31.50**	**30.59**	**6.11**
	Girls.		847	10.81	10.64	2.52	395	15.21	15.57	3.13	559	26.48	25.65	5.59
Eleven.....	**Boys.**	"	**823**	**14.64**	**15.20**	**3.05**	**340**	**21.99**	**20.96**	**4.04**	**481**	**35.63**	**35.26**	**6.40**
	Girls.		761	11.92	11.72	2.46	373	17.53	18.62	3.82	479	30.36	30.38	5.78
Twelve.....	**Boys.**	"	**678**	**17.24**	**16.98**	**3.36**	**347**	**25.90**	**25.75**	**4.93**	**481**	**40.35**	**40.16**	**7.43**
	Girls.		730	13.71	13.81	3.01	313	20.46	20.64	3.95	510	33.60	32.61	7.27
Thirteen.....	**Boys.**	"	**534**	**18.82**	**19.11**	**3.75**	**257**	**30.36**	**30.47**	**5.60**	**361**	**46.22**	**45.42**	**9.14**
	Girls.		575	16.52	15.96	3.41	261	24.97	25.15	4.72	420	39.38	35.96	8.55
Fourteen.....	**Boys.**	"	**399**	**22.61**	**22.28**	**4.12**	**189**	**36.26**	**35.52**	**6.97**	**260**	**51.83**	**50.74**	**9.65**
	Girls.		491	18.63	18.55	4.20	171	28.27	28.92	5.92	288	42.98	40.45	10.60
Fifteen.....	**Boys.**	"	**249**	**27.23**	**26.79**	**5.39**	**79**	**41.68**	**40.88**	**7.46**	**119**	**64.85**	**63.36**	**1.27**
	Girls.		343	19.88	20.37	3.30	87	32.45	32.50	5.78	187	48.11	49.10	9.90
Sixteen.....	**Boys.**	"	**102**	**30.42**	**30.55**	**5.29**	**31**	**43.32**	**41.85**	**13.59**	**30**	**86.40**	**80.00**	**1.37**
	Girls.		219	20.81	20.90	3.30	43	37.00	36.50	6.17	94	51.48	51.00	10.08
Seventeen.....	**Boys.**	"	**21**	**37.38**	**30.70**									
	Girls.		112	21.88	22.25	3.78								
Eighteen.....	Girls.	"	75	24.13	24.88	4.82								
Nineteen.....	Girls.	"	53	21.82	22.25	3.27								
Twenty.....	Girls.	"	61	22.92	22.81	2.19								
Twenty-one ..	Girls.	"	38		24.00									

TABLE No. 46.

The Strength of Squeeze, Left Hand.

Age at nearest birthday.	Sex.	Unit of Measurement.	Dynamometers A. & D.				Dynamometer B.				Dynamometers C. & E.			
			No. of Observations.	Average.	Median	Probable Deviation.	No. of Observations.	Average.	Median	Probable Deviation.	No. of Observations.	Average.	Median	Probable Deviation.
Six	**Boys.**	Kilogram.	**158**	**4.80**	**5.57**	**1.43**	**198**	**9.39**	**10.28**	**2.11**	**273**	**14.77**	**15.38**	**3.72**
	Girls.		196	3.77	5.00	1.49	202	8.12	8.72	2.05	288	13.24	14.37	3.85
Seven	**Boys.**	"	**440**	**6.75**	**7.02**	**1.72**	**423**	**11.26**	**10.96**	**2.38**	**687**	**18.56**	**18.09**	**4.74**
	Girls.		376	5.53	5.87	1.57	393	8.42	10.35	2.56	719	15.30	15.47	4.06
Eight	**Boys.**	"	**741**	**9.27**	**9.39**	**2.64**	**379**	**13.10**	**13.10**	**2.54**	**762**	**21.35**	**20.96**	**4.77**
	Girls.		745	7.90	7.49	2.43	404	10.88	10.77	2.26	733	19.08	18.62	5.18
Nine	**Boys.**	"	**876**	**11.14**	**10.68**	**3.06**	**351**	**15.11**	**15.22**	**3.09**	**780**	**25.94**	**25.48**	**7.15**
	Girls.		830	8.44	8.54	2.43	328	12.30	12.27	2.72	670	22.20	20.97	5.14
Ten	**Boys.**	"	**947**	**12.31**	**11.62**	**3.14**	**365**	**17.26**	**17.21**	**3.65**	**574**	**29.25**	**30.03**	**5.58**
	Girls.		847	10.06	10.30	2.64	392	14.15	14.76	3.08	559	24.82	25.14	5.04
Eleven	**Boys.**	"	**824**	**14.04**	**13.66**	**3.20**	**338**	**19.94**	**20.25**	**3.97**	**488**	**33.87**	**32.60**	**5.83**
	Girls.		762	10.95	10.81	2.54	374	16.52	16.57	3.62	480	28.90	29.29	5.41
Twelve	**Boys.**	"	**673**	**15.86**	**15.61**	**3.20**	**348**	**23.65**	**23.71**	**5.24**	**481**	**37.47**	**35.84**	**6.86**
	Girls.		732	12.71	12.60	3.30	310	18.80	20.22	4.16	512	32.34	30.78	7.24
Thirteen	**Boys.**	"	**535**	**17.47**	**17.32**	**3.69**	**258**	**27.39**	**26.83**	**5.52**	**355**	**41.98**	**40.58**	**8.05**
	Girls.		574	15.25	15.24	3.48	261	23.09	23.05	5.26	422	35.82	35.08	7.80
Fourteen	**Boys.**	"	**402**	**20.46**	**20.68**	**3.90**	**191**	**32.66**	**31.44**	**5.96**	**261**	**48.27**	**45.90**	**10.01**
	Girls.		490	17.13	17.06	3.92	171	26.31	26.00	4.98	286	43.18	38.75	11.20
Fifteen	**Boys.**	"	**247**	**24.39**	**24.69**	**4.74**	**69**	**40.12**	**39.50**	**8.42**	**123**	**54.03**	**55.00**	**12.74**
	Girls.		343	18.05	18.25	3.45	87	28.89	30.32	6.26	188	44.99	45.29	10.00
Sixteen	**Boys.**	"	**101**	**28.17**	**29.50**	**4.91**	**30**	**40.33**	**39.75**	**10.17**	**31**	**68.52**	**70.20**	**13.15**
	Girls.		221	19.34	19.29	3.24	42	31.74	32.75	5.35	96	49.41	47.40	12.56
Seventeen	**Boys.**	"	**36**	**30.97**	**31.67**	**4.87**					**22**	**68.77**	**70.00**	**11.79**
	Girls.		112	19.79	19.40	3.24					32	49.78	50.25	7.54
Eighteen	Girls.	"	75	23.48	23.50	5.05								
Nineteen	Girls.	"	53	20.79	21.17	3.40								
Twenty	Girls.	"	62	22.19	22.67	2.23								
Twenty-one.	Girls.	"	38	23.28	23.00	2.88								

TABLE No. 47.

The Length of Head.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations	Unit of Measurement	Average.	Probable Error of Average. E.	Probable Deviation. d.	Relation of Probable Deviation to Av'rage. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
					±	±	%	%		%				
Six	**Boys.**	**606**	Milli-	**178.39**	**0.171**	**4.21**	**2.36**	**16.4**			**174.63**	**178.86**	**182.79**	**+0.47**
	Girls.	606	metre.	173.45	0.170	4.20	2.42	16.1			170.19	174.34	178.14	+0.89
Seven	**Boys.**	**1493**	"	**178.54**	**0.118**	**4.57**	**2.56**	**15.7**	**0.15**	**0.08**	**174.84**	**179.92**	**183.79**	**+0.38**
	Girls.	1511		174.09	0.108	4.22	2.42	15.4	0.64	0.37	171.41	175.58	179.76	+0.49
Eight	**Boys.**	**2079**	"	**179.62**	**0.106**	**4.85**	**2.70**	**15.1**	**1.08**	**0.60**	**176.03**	**180.44**	**184.87**	**+0.82**
	Girls.	2125		175.18	0.092	4.26	2.43	14.8	1.09	0.63	172.17	176.41	180.82	+1.23
Nine	**Boys.**	**1986**	"	**180.72**	**0.109**	**4.87**	**2.69**	**14.5**	**1.10**	**0.61**	**176.71**	**181.00**	**185.69**	**+0.28**
	Girls.	1884		176.39	0.101	4.39	2.49	14.3	1.21	0.69	173 69	177.80	181.68	+1.41
Ten	**Boys.**	**1912**	"	**181.45**	**0.094**	**4.13**	**2.28**	**14.1**	**0.73**	**0.40**	**178.10**	**181.51**	**185.85**	**+0.06**
	Girls.	1790		177.24	0.102	4.33	2.44	13.8	0.85	0.48	174.15	178.52	182.47	+1.28
Eleven	**Boys.**	**1654**	"	**182.37**	**0.129**	**5.26**	**2.89**	**13.6**	**0.92**	**0.50**	**178.85**	**182.86**	**187.26**	**+0.49**
	Girls.	1560		178.08	0.119	4.70	2.64	13.4	0.84	0.47	174.71	179.75	183.78	+1.67
Twelve	**Boys.**	**1576**	"	**182.84**	**0.115**	**4.56**	**2.49**	**13.2**	**0.47**	**0.26**	**179.19**	**183.08**	**187.52**	**+0.24**
	Girls.	1516		179.50	0.114	4.46	2.49	12.9	1.42	0.80	176.43	180.57	184.86	+1.07
Thirteen	**Boys.**	**1207**	"	**183.84**	**0.131**	**4.55**	**2.48**	**12.9**	**1.00**	**0.55**	**179.93**	**184.21**	**188.78**	**+0.37**
	Girls.	1187		181.44	0.132	4.55	2.51	12.4	1.94	1.08	178.35	182.48	187.05	+1.04
Fourteen	**Boys.**	**890**	"	**186.93**	**0.182**	**5.44**	**2.91**	**12.6**	**3.09**	**1.68**	**182.08**	**186.24**	**190.75**	**−0.69**
	Girls.	1008		183.41	0.143	4.53	2.47	12.2	1.97	1.09	180.07	184.71	188.73	+1.30
Fifteen	**Boys.**	**502**	"	**187.01**	**0.208**	**4.66**	**2.49**	**12.1**	**0.08**	**0.04**	**183.01**	**187.69**	**191.97**	**+0.68**
	Girls.	649		185.12	0.180	4.58	2.47	11.9	1.71	0.93	181.53	185.67	190.90	+0.55
Sixteen	**Boys.**	**191**	"	**189.06**	**0.355**	**4.93**	**2.61**	**11.8**	**2.05**	**1.10**	**184.79**	**190.04**	**194.77**	**+0.98**
	Girls.	400		186.84	0.256	5.12	2.74	12.1	1.72	0.93	183.02	187.70	192.47	+0.86
Seventeen	**Boys.**	**78**	"	**189.45**	**0.575**	**5.08**	**2.68**	**11.5**	**0.39**	**0.21**		**190.93**		**+1.48**
	Girls.	221		188.14	0.275	4.09	2.17	11.8	1.30	0.70	184.58	188.60	192.60	+0.46
Eighteen	**Boys.**	**32**	"	**193.91**	**0.717**	**4.13**	**2.13**	**11.4**	**4.46**	**2.35**		**193.75**		**−0.16**
	Girls.	161		187.97	0.252	3.20	1.70	11.9			184.79	188.41	191.86	+0.44
Nineteen	Girls.	77	"	187.91	0.466	4.09	2.18	11.8			184.36	188.31	191.75	+0.40
Twenty	Girls.	75	"	187.81	0.433	3.75	2.01	11.7				188.08		+0.27
Twenty-one	Girls.		"											

TABLE No. 48.

The Width of Head.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E.	Probable Deviation. d.	Relation of Probable Deviation to Av'rage. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.	Width / Length Index.
							%	%		%					
Six	**Boys.**	**573**	Millimetre.	**143.29**	**0.118**	**2.82**	**1.97**	**13.2**			**140.77**	**143.76**	**147.11**	**+0.47**	**0.80**
	Girls.	609		140.27	0.154	3.81	2.72	13.0			137.21	140.83	144.54	+0.56	0.81
Seven	**Boys.**	**1571**	"	**144.37**	**0.090**	**3.58**	**2.48**	**12.7**	**1.08**	**0.75**	**141.57**	**144.98**	**148.26**	**+0.61**	**0.81**
	Girls.	1505		141.40	0.099	3.86	2.73	12.5	1.13	0.81	138.63	142.10	145.44	+0.70	0.81
Eight	**Boys.**	**1997**	"	**145.30**	**0.082**	**3.68**	**2.53**	**12.2**	**0.93**	**0.64**	**142.37**	**145.63**	**149.43**	**+0.33**	**0.81**
	Girls.	1985		142.31	0.082	3.66	2.57	12.0	0.91	0.64	139.50	142.84	146.30	+0.53	0.81
Nine	**Boys.**	**1962**	"	**145.87**	**0.084**	**3.74**	**2.56**	**11.7**	**0.57**	**0.39**	**142.79**	**146.08**	**150.05**	**+0.21**	**0.81**
	Girls.	1914		143.04	0.083	3.65	2.55	11.6	0.73	0.51	140.47	143 58	147.01	+0.54	0.81
Ten	**Boys.**	**1827**	"	**146.59**	**0.090**	**3.85**	**2.63**	**11.4**	**0.72**	**0.49**	**143.40**	**147.11**	**151.02**	**+0.52**	**0.81**
	Girls.	1803		143.75	0.093	3.96	2.76	11.2	0.71	0.50	140.99	144.54	148.02	+0.79	0 81
Eleven	**Boys.**	**1561**	"	**147.29**	**0.095**	**3.76**	**2.55**	**11.0**	**0.70**	**0.48**	**144.30**	**147.50**	**151.42**	**+0.31**	**0.81**
	Girls.	1541		145.05	0.097	3.80	2.62	10.9	1.31	0.90	142.06	145.54	149.33	+0.49	0.81
Twelve	**Boys.**	**1531**	"	**147.98**	**0.092**	**3.61**	**2.44**	**10.7**	**0.69**	**0.47**	**145.19**	**148.36**	**152.08**	**+0.38**	**0.81**
	Girls.	1460		145.64	0.105	4.03	2.77	10.5	0.59	0.42	142.91	146.31	150.06	+0.67	0.81
Thirteen	**Boys.**	**1175**	"	**148.73**	**0.114**	**3.90**	**2.62**	**10.4**	**0.75**	**0.51**	**145.46**	**149.01**	**152.98**	**+0.27**	**0.81**
	Girls.	1167		146.78	0.115	3.92	2.67	10.0	1.14	0.78	143.44	147.15	151.17	+0.37	0.81
Fourteen	**Boys.**	**873**	"	**149.50**	**0.129**	**3.82**	**2.56**	**10.1**	**0.77**	**0.52**	**146.04**	**150.04**	**153.42**	**+0.54**	**0.80**
	Girls.	927		147.90	0.130	3.96	2.68	9.8	1.12	0.76	144.57	148.25	152.14	+0.35	0.81
Fifteen	**Boys.**	**469**	"	**149.63**	**0.186**	**4.03**	**2.69**	**9.7**	**1.13**	**0.87**	**146.24**	**150.41**	**154.04**	**+0.78**	**0.80**
	Girls.	658		148.29	0.150	3.84	2.59	9.6	0.39	0.26	145.16	148.71	152.63	+0.42	0.80
Sixteen	**Boys.**	**195**	"	**150.98**	**0.249**	**3.48**	**2.31**	**9.4**	**1.35**	**0.90**	**147.75**	**151.35**	**154.96**	**+0.37**	**0.80**
	Girls.	395		148.95	0.210	4.17	2.80	9.4	0.66	0.44	145.85	149.67	153.44	+0.72	0.80
Seventeen	**Boys.**	**75**	"	**152.09**	**0.486**	**4.21**	**2.77**	**9.2**	**1.11**	**0.74**	**149.84**	**152.50**	**156.55**	**+0.41**	**0.80**
	Girls.	221		150.04	0.242	3.60	2.40	9.4	1.09	0.73	146.99	150.43	154.38	+0.39	0.80
Eighteen	**Boys.**	**32**	"	**151.66**	**0.685**	**3.88**	**2.56**	**8.9**				**152.00**		**+0.34**	**0.78**
	Girls.	165		149.09	0.300	3.85	2.58	9.4			145.96	150.16	153.21	+1.07	0.79
Nineteen	Girls.	79	"	149.11	0.466	4.14	2.78	9.4			146.08	150.17	154.10	+1.06	0.79
Twenty	Girls.	73	"	147.82	0.426	3.64	2.46	9.2			144.69	147.70	152.26	—0.12	0.79
Twenty-one	Girls.		"												

TABLE No. 49.

The Height of Face from Root of Nose to Point of Chin.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. *E.*	Probable Deviation *d.*	Relation of Probable Deviation to Average. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
							%	%		%				
Six	**Boys.**	**604**	Millimetre.	**93.72**	**0.207**	**5.09**	**5.23**	**8.6**			**89.24**	**93.20**	**99.45**	**—0.52**
	Girls.	612		91.42	0.194	4.80	5.25	8.5			86.88	90.89	96.46	—0.53
Seven	**Boys.**	**1580**	"	**95.87**	**0.120**	**4.80**	**5.06**	**8.4**	**2.15**	**2.89**	**91.28**	**95.57**	**101.11**	**—0.30**
	Girls.	1509		93.77	0.115	4.45	4.75	8.3	2.35	2.57	89.35	93.20	98.38	—0.57
Eight	**Boys.**	**2057**	"	**97.98**	**0.103**	**4.67**	**4.77**	**8.2**	**2.11**	**2.20**	**93.73**	**97.78**	**102.71**	**—0.20**
	Girls.	2016		95.65	0.099	4.46	4.66	8.1	1.88	2.01	91.67	95.60	99.79	—0.05
Nine	**Boys.**	**2011**	"	**99.51**	**0.107**	**4.82**	**4.84**	**8.0**	**1.53**	**1.56**	**95.04**	**99.42**	**104.25**	**—0.09**
	Girls.	1898		97.85	0.103	4.48	5.76	7.9	2.20	2.30	93.61	97.60	102.31	—0.25
Ten	**Boys.**	**1868**	"	**101.06**	**0.110**	**4.77**	**4.72**	**7.7**	**1.55**	**1.56**	**96.66**	**100.73**	**105.93**	**—0.33**
	Girls.	1820		99.39	0.109	4.64	4.67	7.8	1.54	1.57	95.04	99.02	104.22	—0.37
Eleven	**Boys.**	**1660**	"	**103.37**	**0.127**	**5.18**	**5.01**	**7.5**	**2.31**	**2.29**	**98.53**	**103.23**	**108.85**	**—0.14**
	Girls.	1572		101.44	0.116	4.61	4.54	7.6	2.05	2.06	97.08	101.20	106.32	—0.24
Twelve	**Boys.**	**1568**	"	**104.25**	**0.132**	**5.22**	**5.01**	**7.4**	**0.88**	**0.85**	**99.88**	**104.45**	**109.77**	**+0.20**
	Girls.	1523		103.46	0.129	5.05	4.88	7.4	2.02	1.99	98.81	103.53	108.83	+0.07
Thirteen	**Boys.**	**1205**	"	**106.24**	**0.160**	**5.54**	**5.21**	**7.3**	**1.99**	**1.91**	**101.64**	**106.34**	**111.76**	**+0.10**
	Girls.	1231		105.92	0.133	4.68	4.42	7.2	2.46	2.38	101.60	105.71	111.15	—0.21
Fourteen	**Boys.**	**893**	"	**108.43**	**0.174**	**5.21**	**4.80**	**7.2**	**2.19**	**2.06**	**103.64**	**108.51**	**113.79**	**+0.08**
	Girls.	997		107.87	0.156	4.94	4.58	7.2	1.95	1.84	103.37	107.72	112.86	—0.15
Fifteen	**Boys.**	**479**	"	**111.63**	**0.238**	**5.21**	**4.67**	**7.1**	**3.20**	**2.95**	**106.04**	**111.52**	**116.88**	**—0.11**
	Girls.	672		109.79	0.192	4.98	4.53	7.1	1.92	1.78	104.56	109.40	114.05	—0.39
Sixteen	**Boys.**	**191**	"	**113.63**	**0.346**	**4.79**	**4.22**	**7.1**	**2.00**	**1.79**	**109.19**	**113.73**	**118.98**	**+0.10**
	Girls.	403		110.48	0.245	4.91	4.45	7.0	0.69	0.63	105.92	109.83	115.48	—0.61
Seventeen	**Boys.**	**78**	"	**117.56**	**0.744**	**6.57**	**5.59**	**7.1**	**3.93**	**3.46**	**112.42**	**118.50**	**122.89**	**+0.94**
	Girls.	223		110.04	0.345	5.15	4.68	6.9			105.11	110.50	115.46	+0.46
Eighteen	**Boys.**	**31**	"	**120.84**	**0.883**	**4.92**	**4.16**		**3.28**	**2.79**		**121.00**		**+0.16**
	Girls.	163		109.77	0.297	3.79	3.45	6.9			105.65	110.04	114.06	+0.27
Nineteen	Girls	80	"	108.72	0.421	3.77	3.50	6.8			104.18	108.34	112.90	—0.38
Twenty	Girls.	73	"	110.26	0.469	4.01	3.64	6.9			106.34	110.30	114.13	+0.04
Twenty-one	Girls.	34	"	110.06	0.627	3.66	3.32					110.00		—0.06

TABLE No. 50.

The Width of Face.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. *E.*	Probable Deviation *d.*	Relation of Probable Deviation to Av'rge. $\frac{d}{A}$	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.	Width / Height Index.	Width / Height (Hair-Line) Index.
					±	±	%	%		%						
Six.....	**Boys.**	**608**	Millimetre.	**117.24**	**0.172**	**4.24**	**3.62**	**10.8**			**114.04**	**118.20**	**121.62**	**+0.96**	**1.25**	**0.77**
	Girls.	608		115.21	0.174	4.30	3.73	10.7			111.92	115.89	119.39	+ 0.68	1.26	0.77
Seven	**Boys.**	**1637**	"	**117.78**	**0.101**	**4.09**	**3.47**	**10.3**	**0.54**	**0.46**	**114.41**	**118.40**	**121.97**	**+0.62**	**1.23**	**0.76**
	Girls.	1516		116.11	0.101	3.92	3.38	10.3	0.90	0.78	112.95	116.38	120.22	+0.27	1.24	0.76
Eight.....	**Boys.**	**2062**	"	**118.82**	**0.090**	**4.08**	**3.44**	**10.0**	**1.04**	**0.88**	**115.65**	**119.75**	**122.96**	**+0.93**	**1.21**	**0.75**
	Girls.	2065		117.63	0.087	3.97	3.38	9.9	1.52	1.31	113.62	117.45	120.99	−0.18	1.23	0.76
Nine	**Boys.**	**1927**	"	**119.91**	**0.101**	**4.44**	**3.70**	**9.6**	**1.09**	**0.92**	**116.54**	**120.75**	**124.59**	**+0.84**	**1.21**	**0.75**
	Girls.	1905		118.02	0.092	4.02	3.41	9.5	0.39	0.33	114.59	118.81	122.18	+0.79	1.21	0.75
Ten	**Boys.**	**1922**	"	**121.60**	**0.092**	**4.05**	**3.33**	**9.4**	**1.69**	**1.41**	**118.02**	**121.63**	**125.32**	**+0.03**	**1.20**	**0.75**
	Girls.	1829		119.49	0.127	4.38	3.67	9.3	1.47	1.25	116 19	120.42	124.04	+0.93	1.20	0.75
Eleven	**Boys.**	**1666**	"	**122.73**	**0.108**	**4.52**	**3.68**	**9.2**	**1.13**	**0.93**	**119.44**	**123.22**	**126.89**	**+0.49**	**1.19**	**0.75**
	Girls.	1504		121.24	0.107	4.17	3.44	9.1	1.75	1.46	117.82	121.71	125.33	+0.47	1.20	0.75
Twelve.....	**Boys.**	**1525**	"	**123.81**	**0.113**	**4.42**	**3.57**	**9.0**	**1.08**	**0.88**	**120.90**	**124.59**	**128.45**	**+0.78**	**1.19**	**0.75**
	Girls.	1526		122.44	0.109	4.26	3.48	8.8	1.20	0.99	119.50	123.07	127.01	+0.63	1.18	0.74
Thirteen.....	**Boys.**	**1213**	"	**125.83**	**0.122**	**4.27**	**3.39**	**8.8**	**2.02**	**1.63**	**121.96**	**126.02**	**129.79**	**+0.19**	**1.19**	**0.75**
	Girls.	1248		124.15	0.127	4.45	3.59	8.5	1.71	1.40	120.62	124.86	128.82	+0.71	1.17	0.74
Fourteen	**Boys.**	**898**	"	**126.81**	**0.153**	**4.56**	**3.59**	**8.5**	**0.98**	**0.78**	**123.17**	**127.32**	**131.64**	**+0.51**	**1.17**	**0.74**
	Girls.	997		125.67	0.135	4.26	3.39	8.3	1.52	1.22	122.31	126.51	130.49	+0.84	1.16	0.72
Fifteen	**Boys.**	**485**	"	**128.32**	**0.196**	**4.33**	**3.37**	**8.3**	**1.51**	**1.19**	**124.02**	**129.03**	**133.72**	**+0.71**	**1.12**	**0.74**
	Girls.	678		127.85	0.157	4.08	3.19	8.2	2.18	1.73	124 51	128.30	132.02	+0.45	1.16	0.72
Sixteen.....	**Boys.**	**193**	"	**130.27**	**0.360**	**5.01**	**3.85**	**8.2**	**1.95**	**1.52**	**126.39**	**130.82**	**134.89**	**+0.55**	**1.15**	**0.73**
	Girls.	409		129.47	0.201	4.07	3.14	8.2	1.62	1.26	126.21	130.18	133.60	+0.71	1.17	0.73
Seventeen	**Boys.**	**79**	"	**131.96**	**0.527**	**4.69**	**3.56**	**8.0**	**1.69**	**1.30**		**133.75**		**+1.79**	**1.12**	**0.72**
	Girls.	219		130.63	0.275	4.08	3.12	8.2	1.16	0.90	127.91	131.38	135.00	+0.75	1.19	0.73
Eighteen	**Boys.**	**33**	"	**135.00**	**0.718**	**4.13**	**3.06**		**3.04**	**2.01**		**135.75**		**+0.75**	**1.12**	**0.74**
	Girls.	163		131.42	0.265	3.38	2.57	8.2	0.79	0.60	129.14	131.97	135.09	+0.55	1.20	0.73
Nineteen.. ...	Girls.	80	"	130.24	0 420	3.76	2 89	8.3				130.44		+0.20	1.20	0.72
Twenty.....	Girls.	73	"	130.75	0.419	3.58	2.74	8.2				132.04		+1.29	1.19	0.73
Twenty-one...	Girls.	34	"		0.528	3.08		8.2				132.00				

TABLE No. 51.

The Height of Face from Hair-Line to Point of Chin.

AGE AT NEAREST BIRTHDAY.	Sex.	Number of Observations.	Unit of Measurement.	Average.	Probable Error of Average. E.	Probable Deviation d.	Relation of Probable Deviation to Average. d/A	Relation of Average to Height Standing.	Absolute Annual Increase of Average.	Relative Annual Increase of Average.	25 Percentile Grade.	Median or 50 Percentile Grade.	75 Percentile Grade.	Median Minus Average.
							%	%		%				
Six	**Boys.**	**611**	Millimetre.	**152.68**	**0.209**	**5.18**	**3.4**	**14.0**			**148.64**	**153.02**	**158.59**	**+0.34**
	Girls.	609		150.16	0.238	5.88	3.9	14.0			144.68	150.45	156.21	+0.39
Seven	**Boys.**	**1621**	"	**154.57**	**0.159**	**6.40**	**4.1**	**13.6**	**1.89**	**1.40**	**150.13**	**155.33**	**160.40**	**+0.76**
	Girls.	1486		153.36	0.137	5.28	3.4	13.6	3.20	2.13	148.73	154.19	159.32	+0.83
Eight	**Boys.**	**2012**	"	**157.50**	**0.122**	**5.46**	**3.5**	**13.2**	**2.93**	**1.36**	**153.04**	**158.04**	**163.10**	**+0.54**
	Girls.	1965		155.19	0.119	5.27	3.4	13.1	1.83	1.19	151.05	155.60	161.11	+0.41
Nine	**Boys.**	**1997**	"	**159.43**	**0.127**	**5.67**	**3.6**	**12.8**	**1.93**	**1.32**	**154.45**	**160.25**	**165.62**	**+0.82**
	Girls.	1989		157.44	0.121	5.38	3.4	12.8	2.25	1.45	152.31	157.76	163.40	+0.32
Ten	**Boys.**	**1909**	"	**161.37**	**0.127**	**5.55**	**3.4**	**12.5**	**1.94**	**1.28**	**156.47**	**161.70**	**167.38**	**+0.33**
	Girls.	1835		160.04	0.131	5.62	3.5	12.5	2.60	1.65	155.36	160.56	166.15	+0.52
Eleven	**Boys.**	**1653**	"	**163.39**	**0.143**	**5.80**	**3.5**	**12.2**	**2.02**	**1.25**	**158.67**	**164.11**	**169.45**	**+0.72**
	Girls.	1581		162.55	0.143	5.70	3.5	12.2	2.51	1.57	157.38	163.40	169.53	+0.85
Twelve	**Boys.**	**1577**	"	**165.23**	**0.137**	**5.44**	**3.3**	**11.9**	**1.84**	**1.22**	**160.37**	**165.62**	**171.54**	**+0.39**
	Girls.	1510		165.29	0.148	5.76	3.5	11.9	2.74	1.69	160.27	165.95	171.40	+0.66
Thirteen	**Boys.**	**1211**	"	**167.62**	**0.173**	**6.01**	**3.6**	**11.7**	**2.39**	**1.20**	**162.59**	**168.16**	**173.87**	**+0.54**
	Girls.	1220		168.35	0.173	6.04	3.6	11.5	3.06	1.85	163.18	169.15	174.85	+0.80
Fourteen	**Boys.**	**896**	"	**170.49**	**0.236**	**7.05**	**4.1**	**11.5**	**2.87**	**1.17**	**165.01**	**171.04**	**177.42**	**+0.55**
	Girls.	998		171.38	0.193	6.11	3.6	11.4	3.08	1.80	163.66	172.00	178.28	+0.62
Fifteen	**Boys.**	**482**	"	**174.30**	**0.292**	**6.41**	**3.7**	**11.3**	**3.81**	**1.15**	**168.74**	**175.08**	**181.23**	**+0.78**
	Girls.	656		174.20	0.211	5.40	3.1	11.2	2.82	1.65	168.92	174.85	180.10	+0.65
Sixteen	**Boys.**	**193**	"	**178.19**	**0.425**	**5.90**	**3.3**	**11.1**	**3.89**	**1.13**	**172.76**	**177.93**	**184.22**	**−0.26**
	Girls.	395		176.28	0.286	5.69	3.2	11.2	2.08	1.19	171.32	176.81	183.09	+0.53
Seventeen	**Boys.**	**79**	"	**182.28**	**0.853**	**7.60**	**4.2**	**11.0**	**4.09**	**1.11**		**182.25**		**−0.03**
	Girls.	201		178.51	0.437	6.20	3.5	11.2	2.23	1.26	173.62	179.41	184.90	+0.90
Eighteen	**Boys.**	**33**	"	**183.67**	**0.139**	**8.00**	**4.4**	**10.8**	**1.39**	**1.10**		**185.66**		**+1.99**
	Girls.	139		180.97	0.520	6.13	3.4	11.4	2.46	1.38	176.32	181.93	186.81	+0.96
Nineteen	Girls.	69	"	181.91	0.749	6.22	3.4	11.4	0.94	0.52	174.29	180.08	185.70	−1.83
Twenty	Girls.	72	"	179.09	0.560	4.76	2.7	11.2			174.80	179.00	184.38	−0.09
Twenty-one	Girls.	33	"	179.97	0.786	4.52	2.5					181.75		+1.78

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CORRIGENDA.

Page 263. Author's name omitted: W. Townsend Porter.

288. Boys, aged 16, hair-line to point of chin should read 0.425 mm.

297. Boys, aged 10, median minus average should read — 0.07 cm.

313. Boys, aged 8, 50 percentile grade should read 119.77 cm.

313. Girls, aged 8, 50 percentile grade should read 118.74 cm.

315. Girls, aged 6, 50 percentile grade should read 107.29 cm.

315. Girls, aged 8, 50 percentile grade should read 118.33 cm.

321. Girls, aged 14, number of observations should read 997.

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VI. Girls' weight (percentile grades).

VII. Boys' height standing (percentile grades).

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XX. Girls' height of face from root of nose to point of chin (percentile grades).

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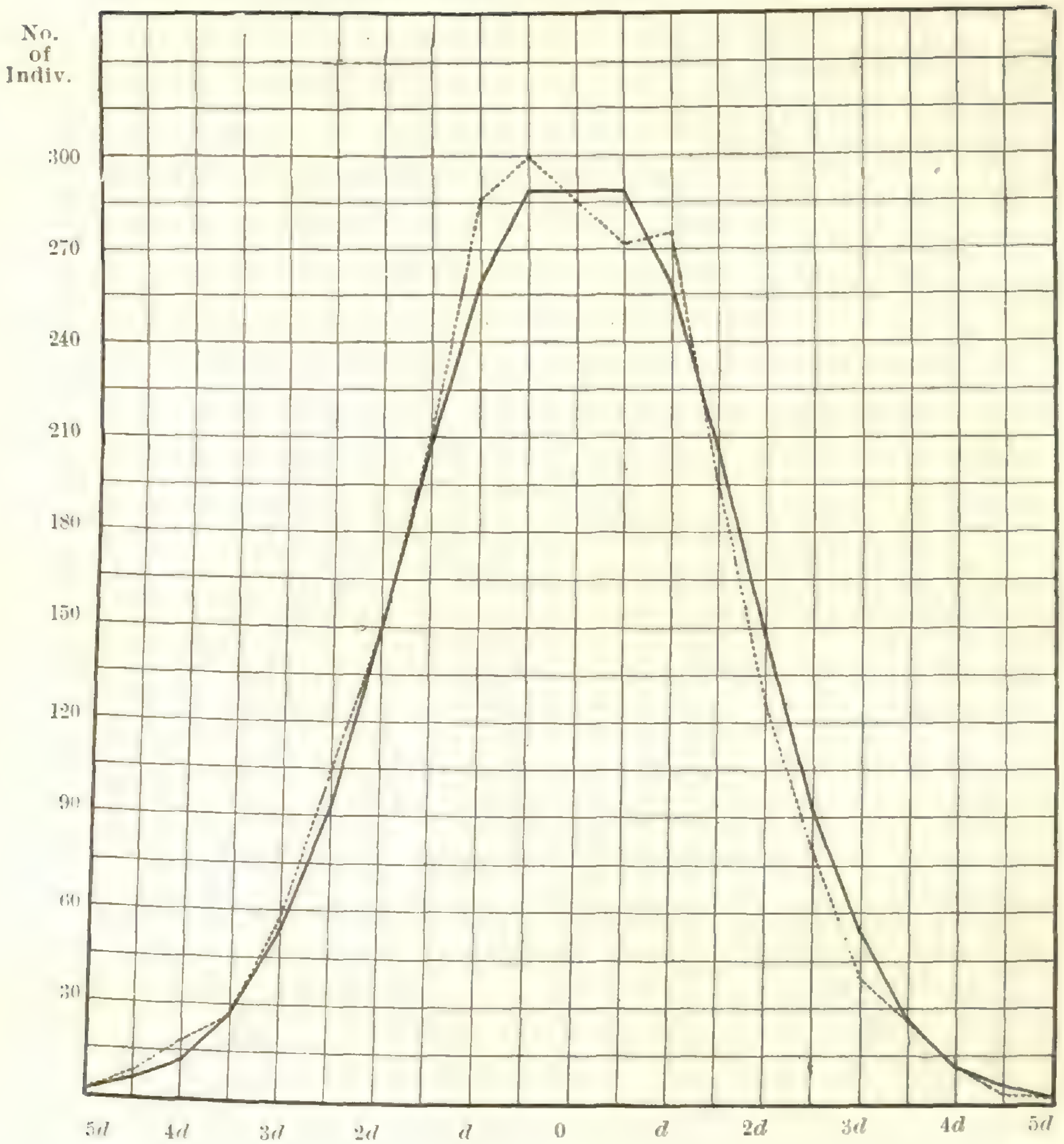
Issued April 14, 1894.

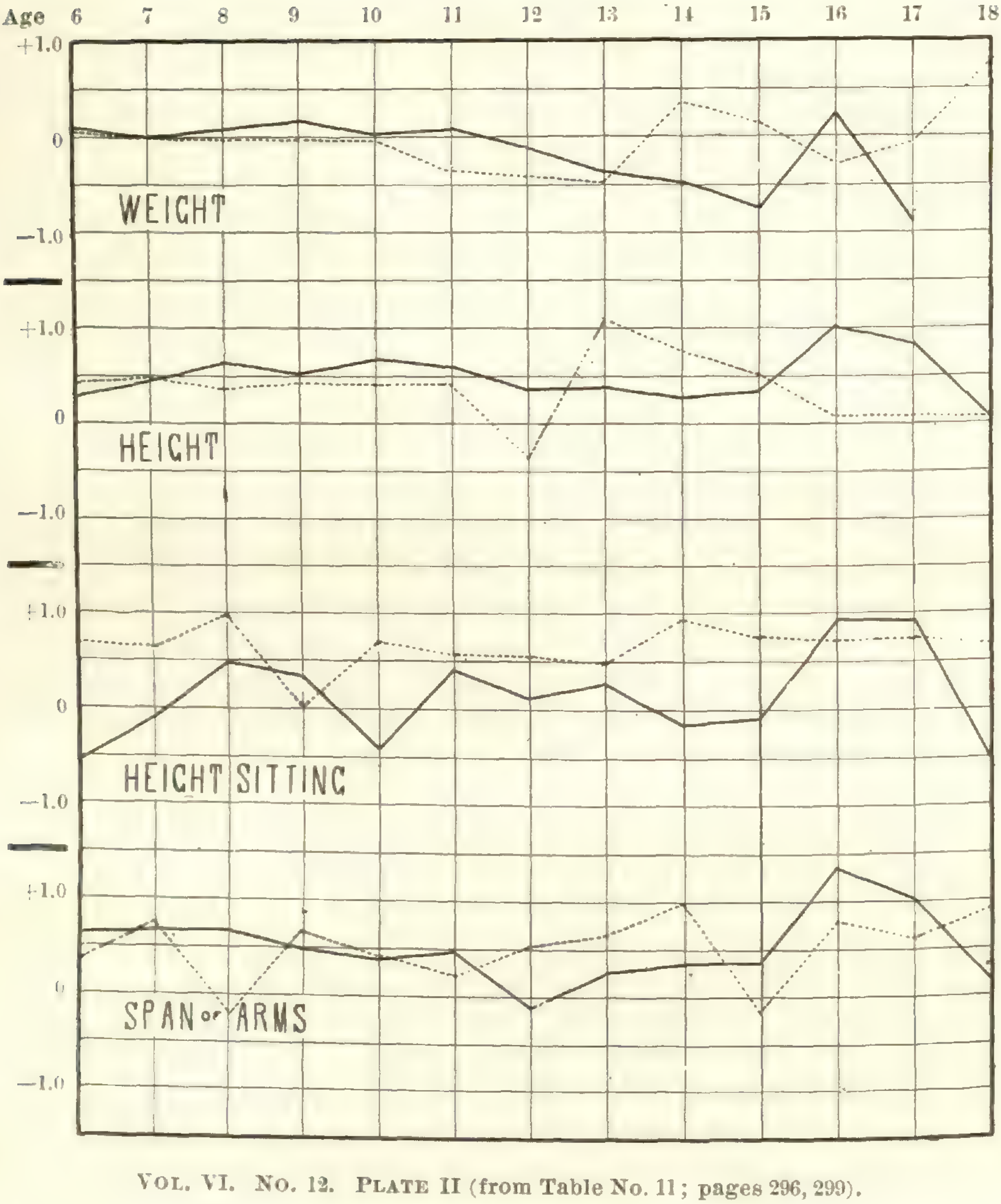


VOL. VI. NO. 12. PLATE I (from Table No. 7; page 286).

The calculated and the observed distribution of the height standing of 2192 St. Louis School Girls, aged 8.

Unbroken Line:
Distribution according to theory.

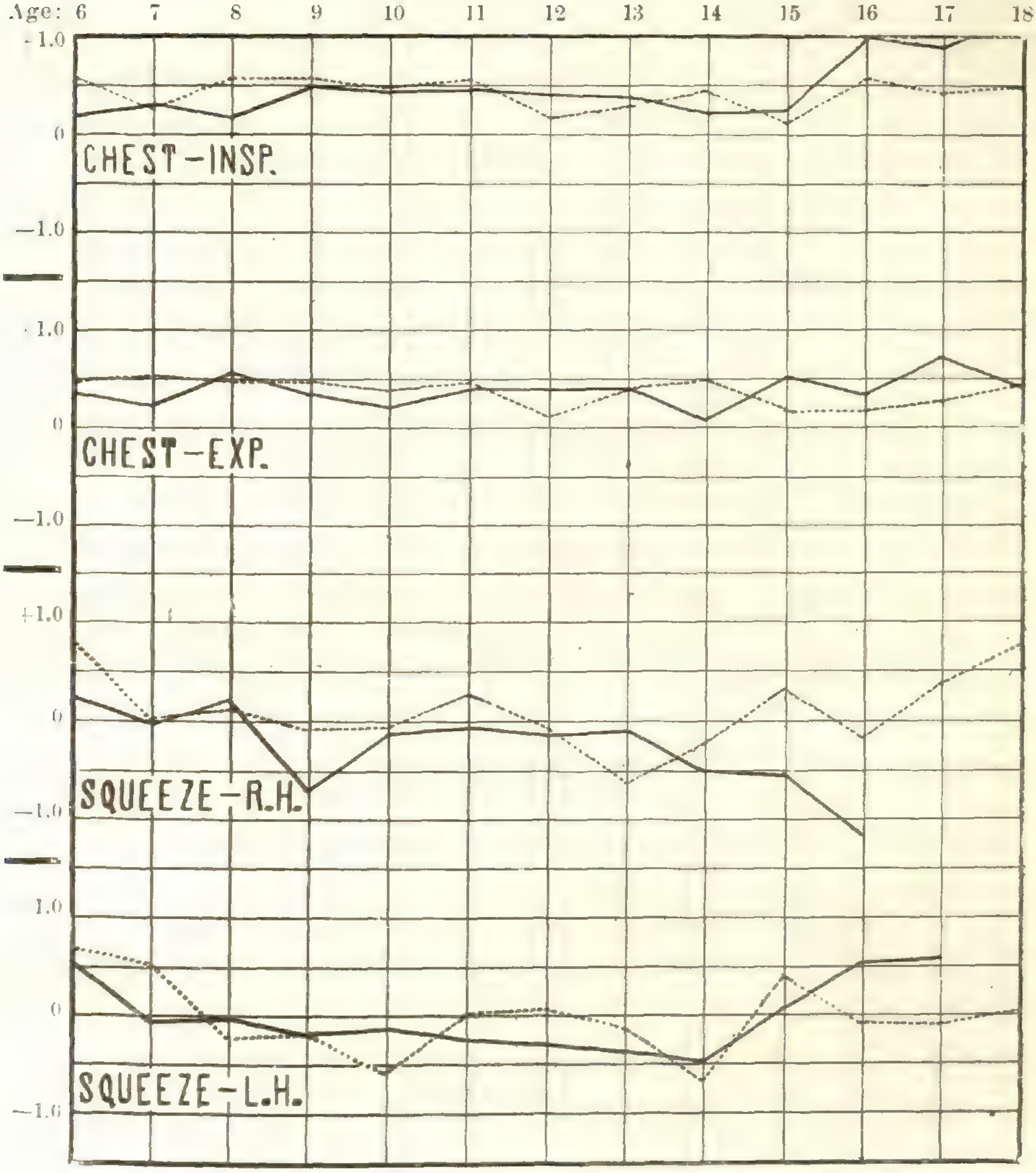
Broken Line:
Distribution according to observation.



VOL. VI. NO. 12. PLATE II (from Table No. 11; pages 296, 299).

Median Minus Average Values.

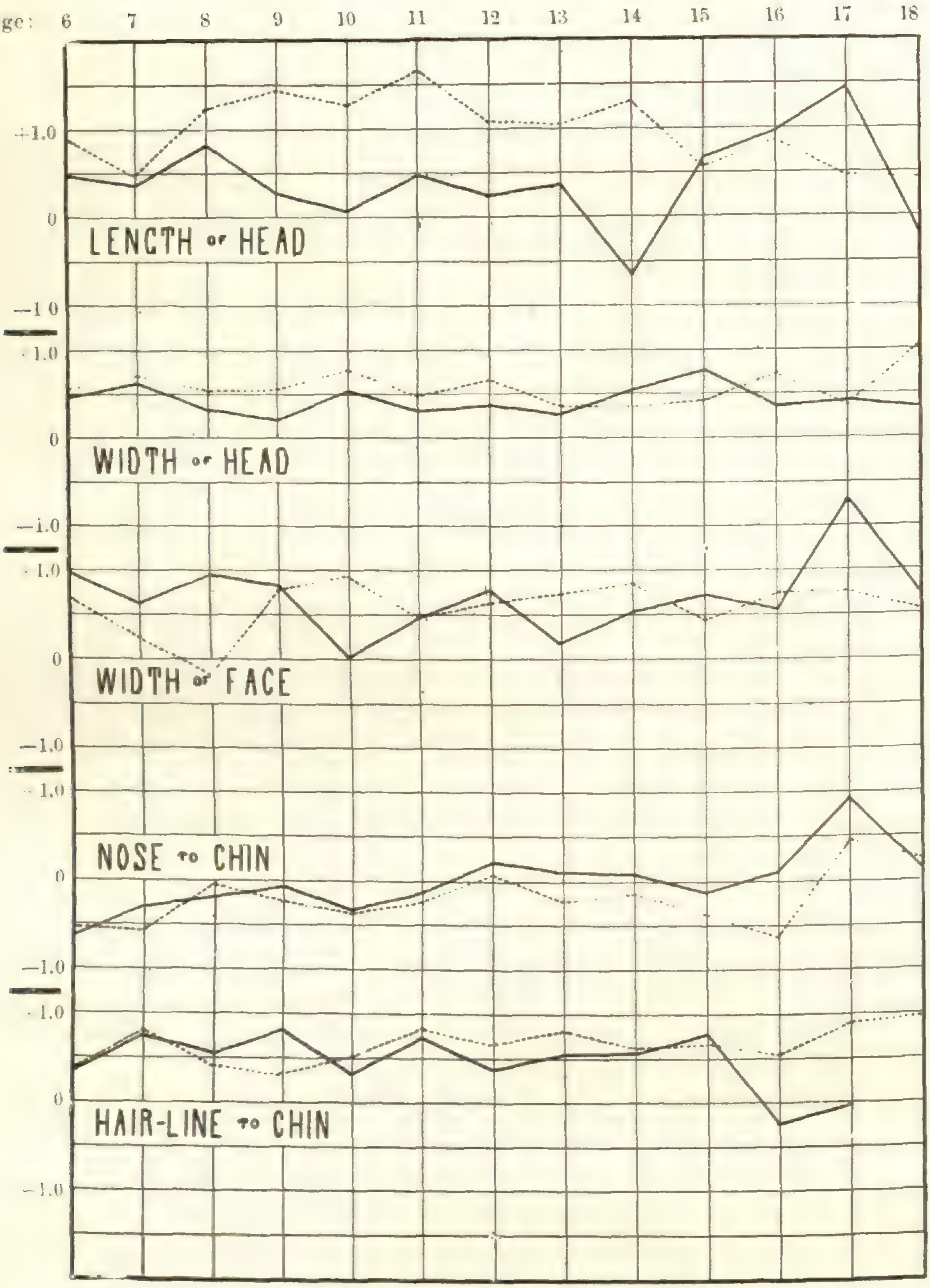
Unbroken Line: Boys. Broken Line: Girls.



VOL. VI. NO. 12. PLATE III (from Table No. 11; pages 296, 299).

Median Minus Average Values.

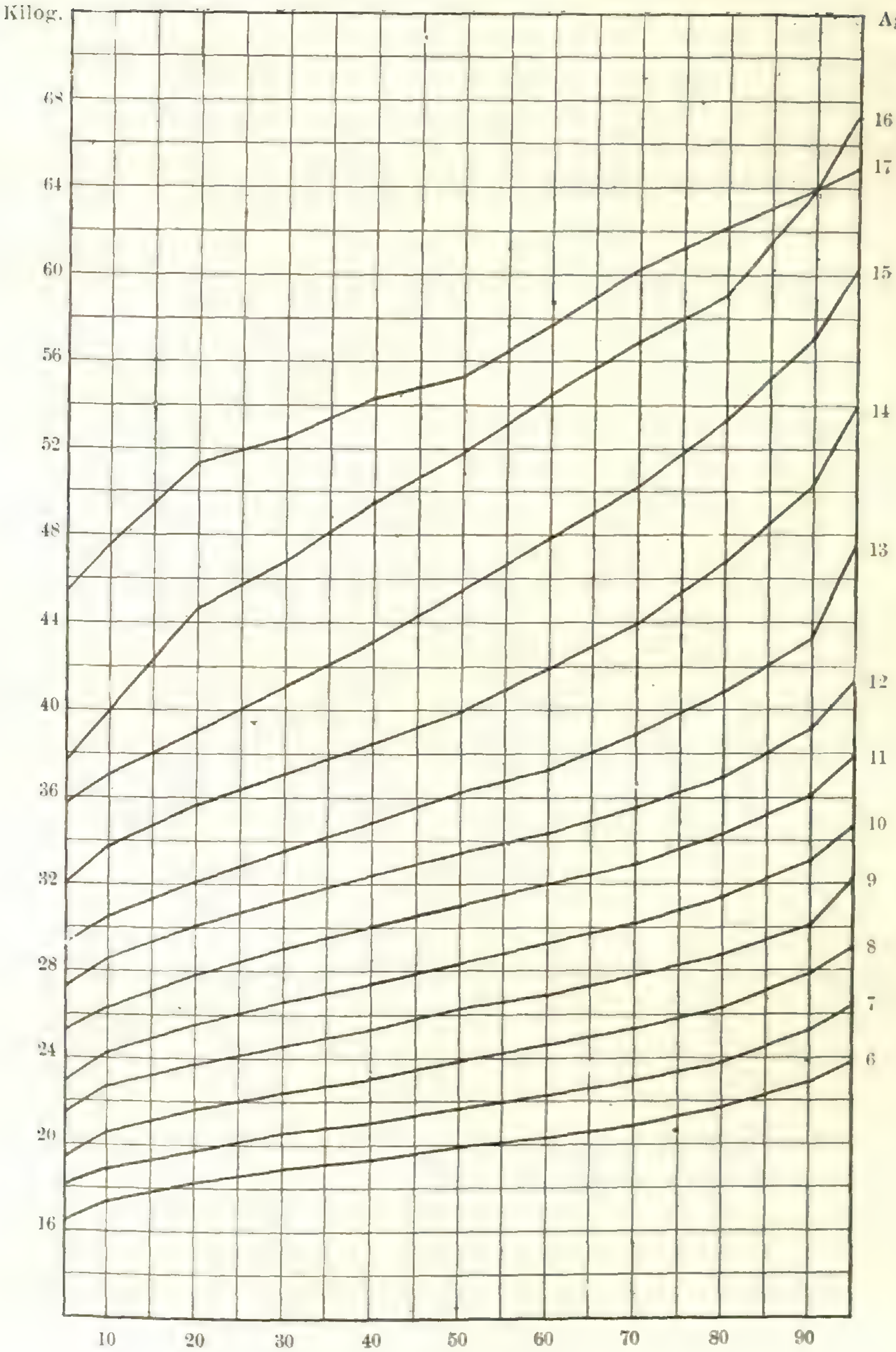
Unbroken Line: Boys. Broken Line: Girls.



VOL. VI. NO. 12. PLATE IV (from Table No. 11; pages 296, 299).

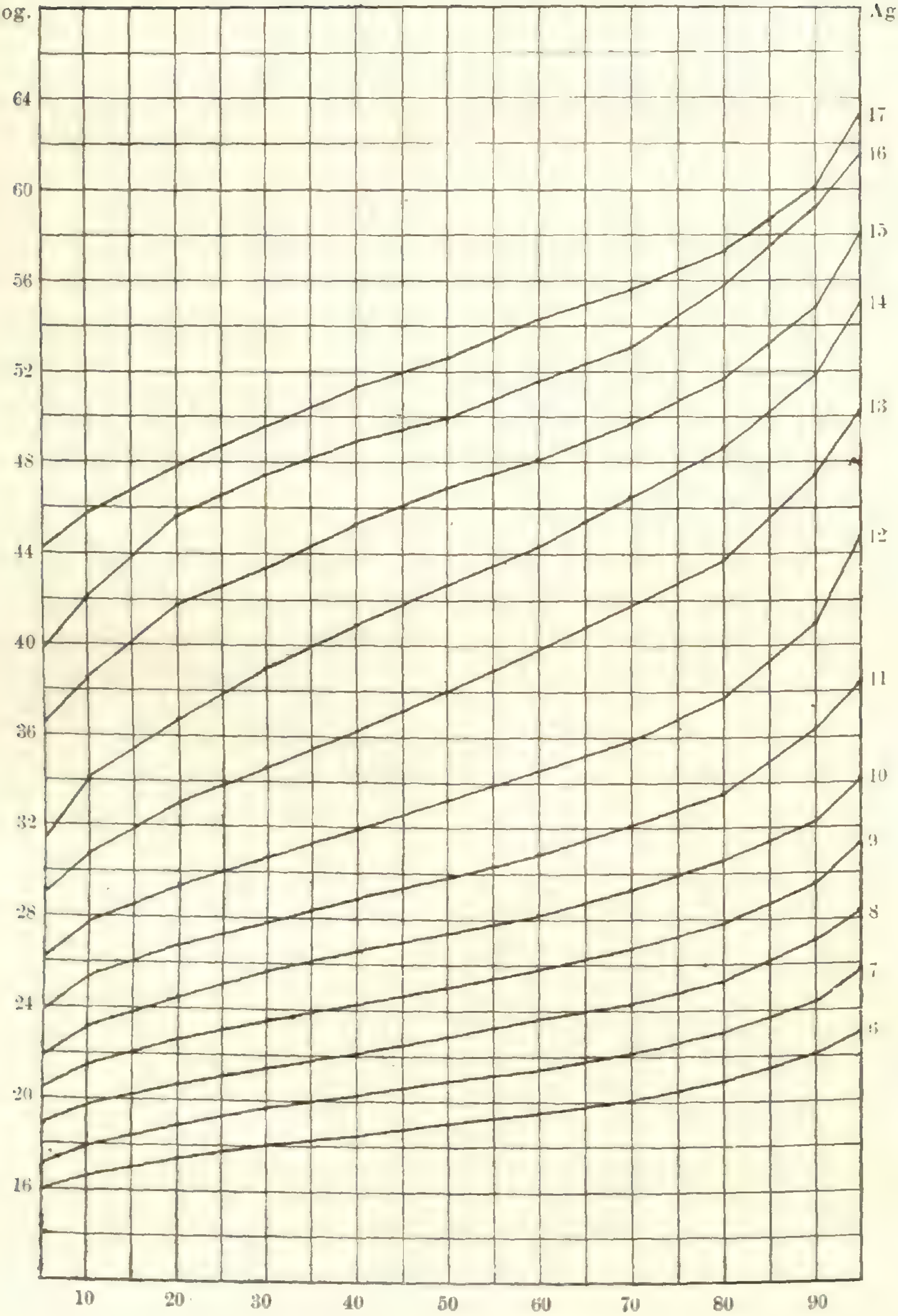
Median Minus Average Values.

Unbroken Line: Boys. Broken Line: Girls.



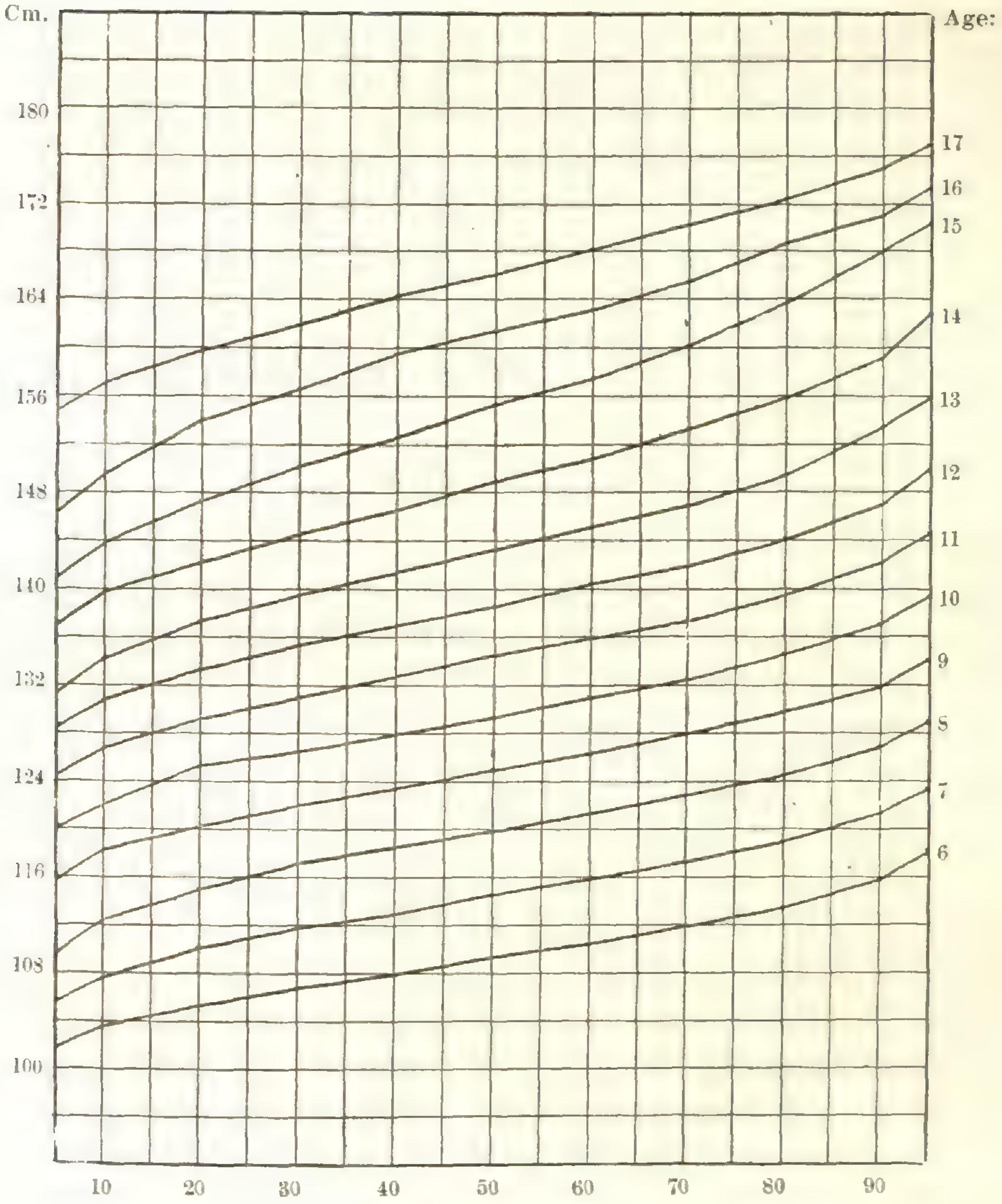
Vol. VI. No. 12. Plate V (from Table No. 17; pages 311, 312).

Boys' Weight.



VOL. VI. NO. 12. PLATE VI (from Table No. 17; pages 311, 312).

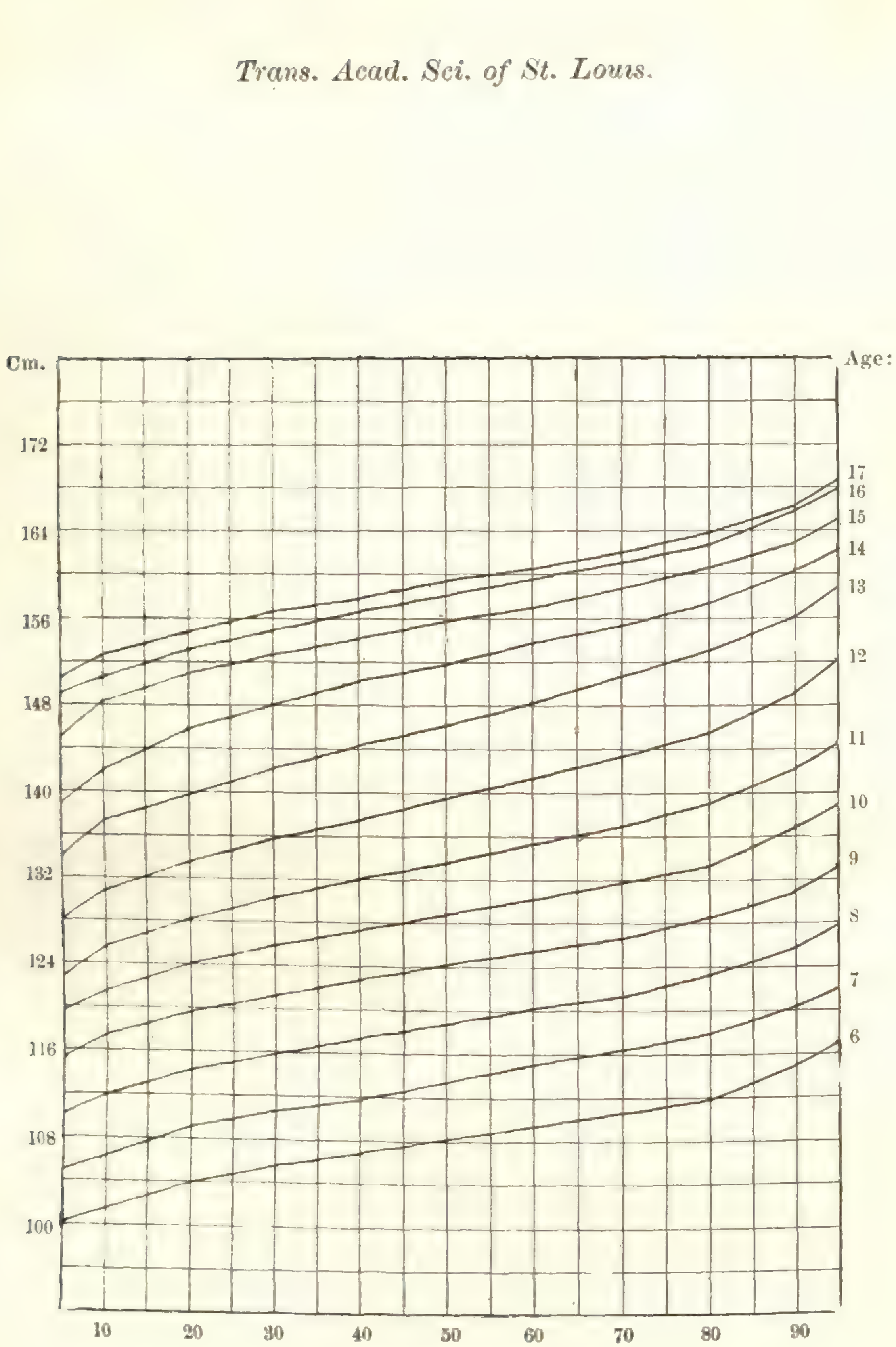
Girls' Weight.



Percentile Grades.

VOL. VI. NO. 12. PLATE VII (from Table No. 18; pages 311, 313).

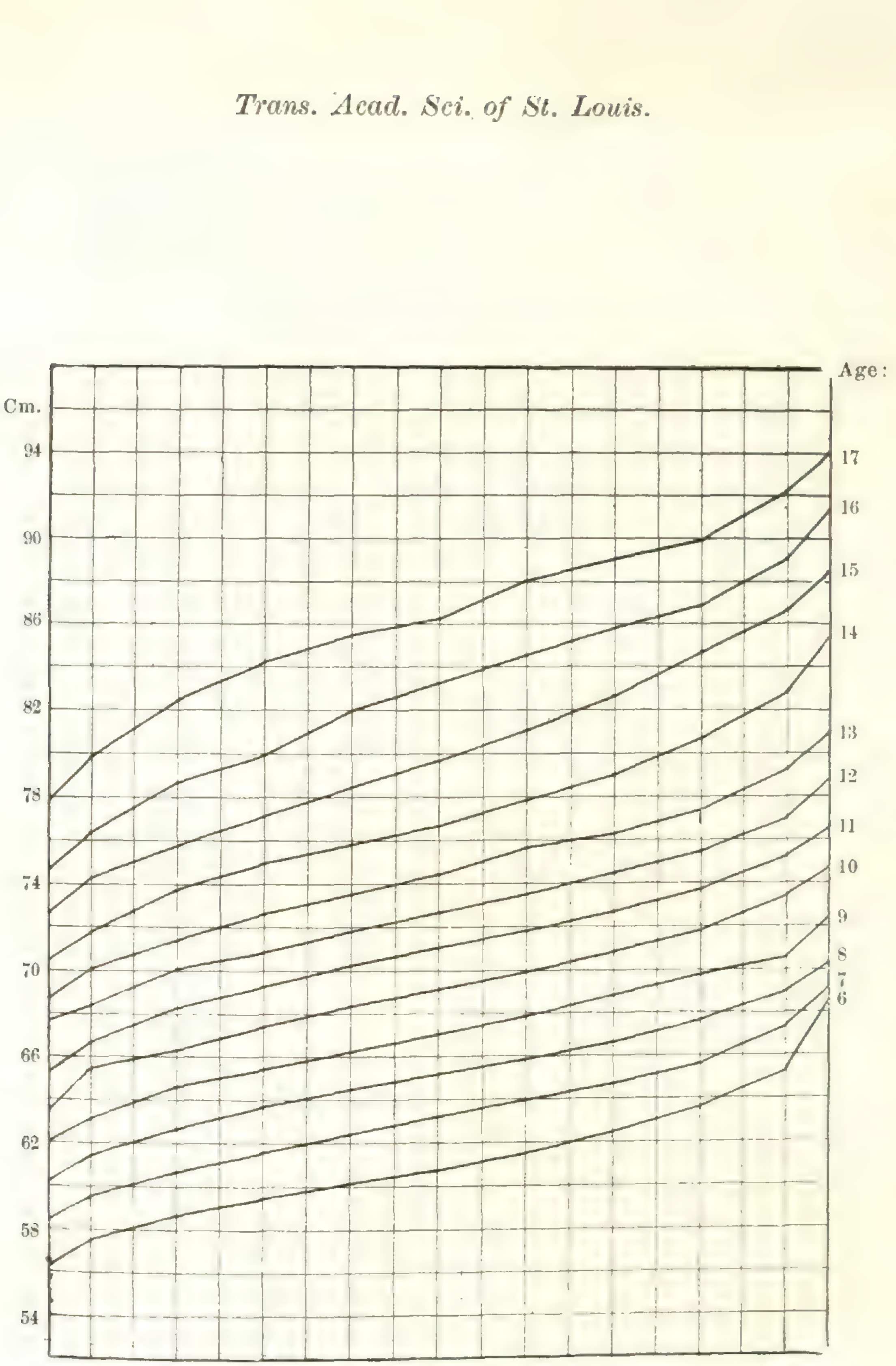
Boys' Height Standing.



Percentile Grades.

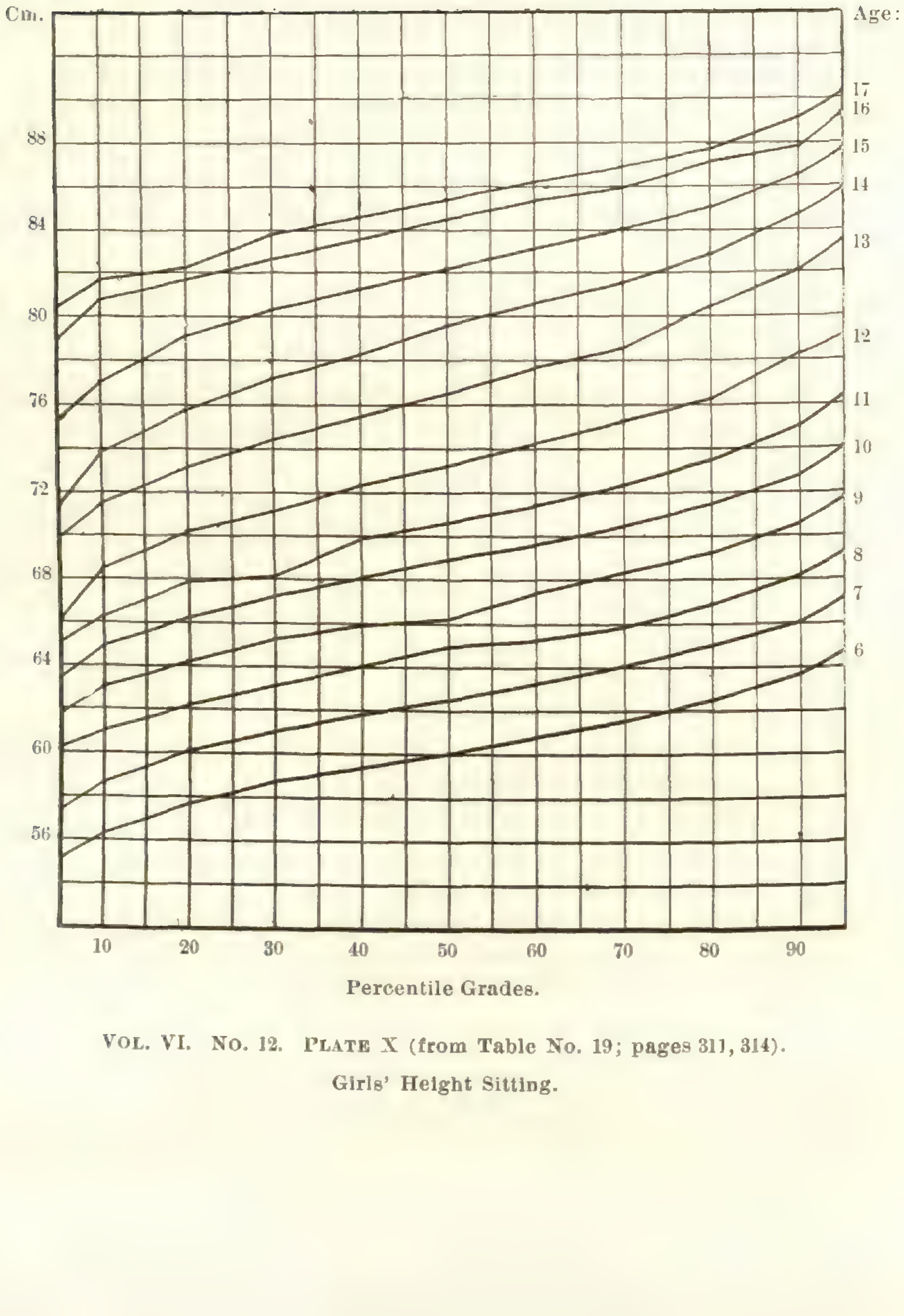
VOL. VI. NO. 12. PLATE VIII (from Table No. 18; pages 311, 313).

Girls' Height Standing.



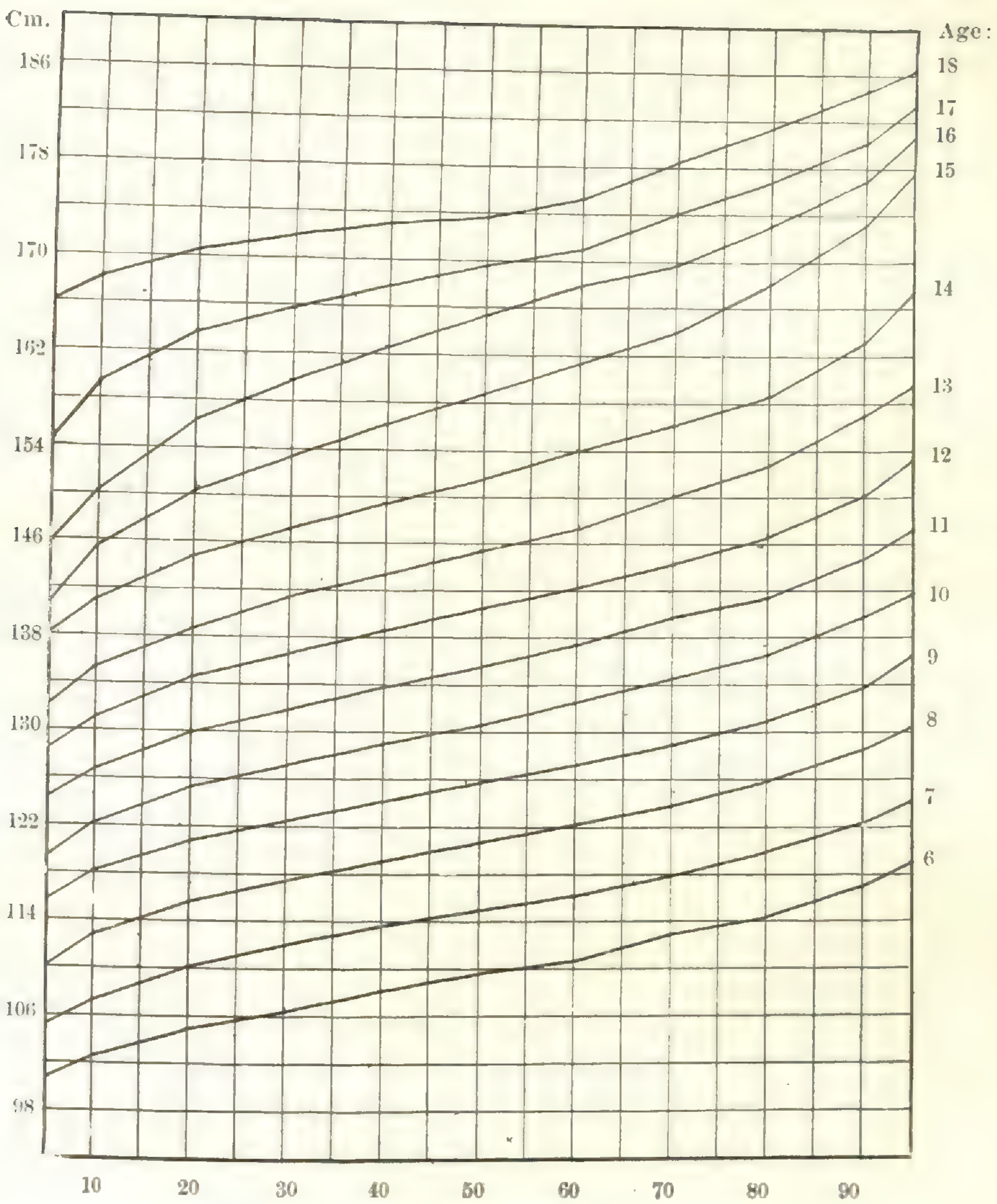
VOL. VI. NO. 12. PLATE IX (from Table No. 19; pages 311, 314).

Boys' Height Sitting.



VOL. VI. NO. 12. PLATE X (from Table No. 19; pages 311, 314).

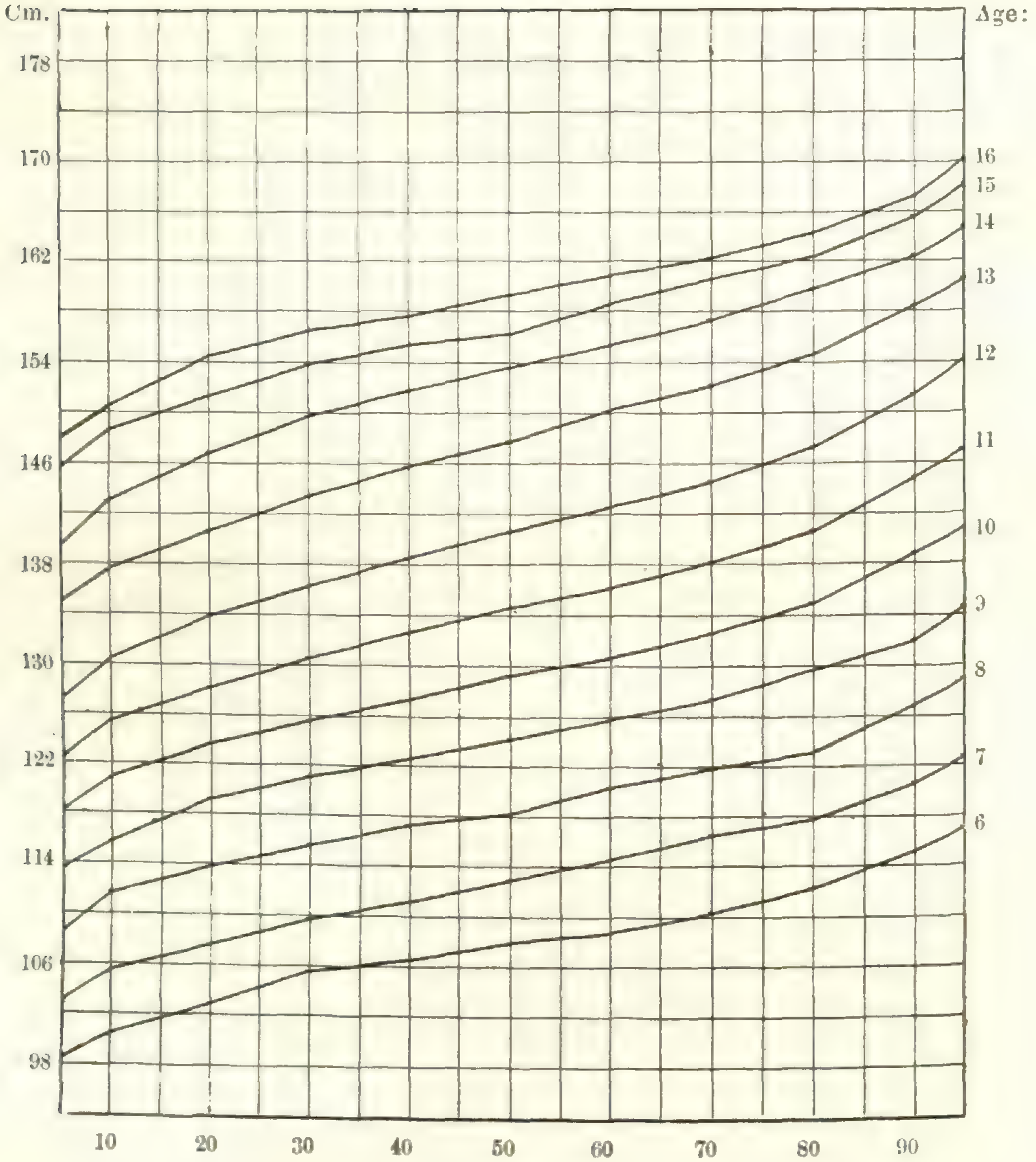
Girls' Height Sitting.



Percentile Grades.

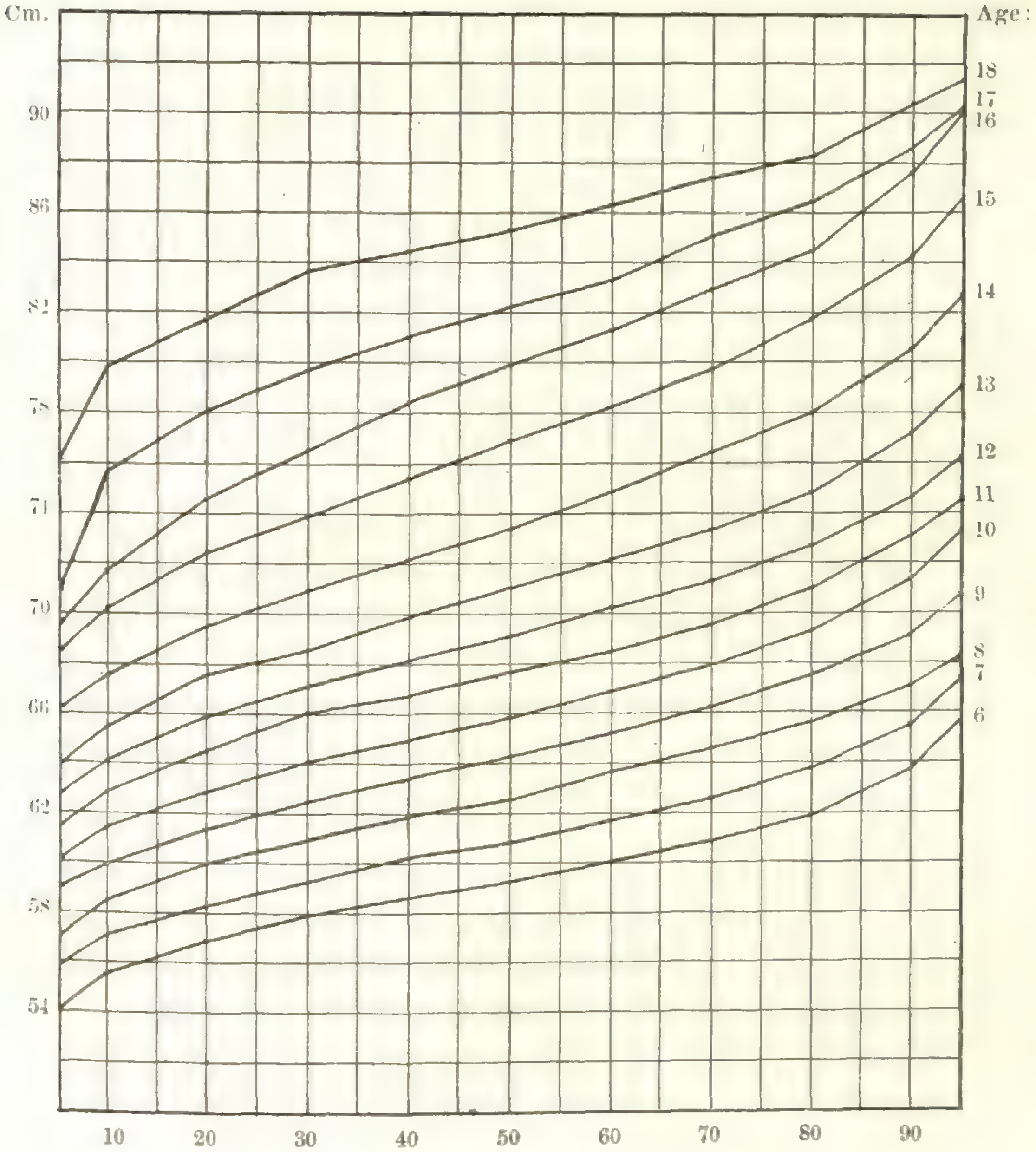
VOL. VI. NO. 12. PLATE XI (from Table No. 20; pages 311, 315).

Boys' Span of Arms.



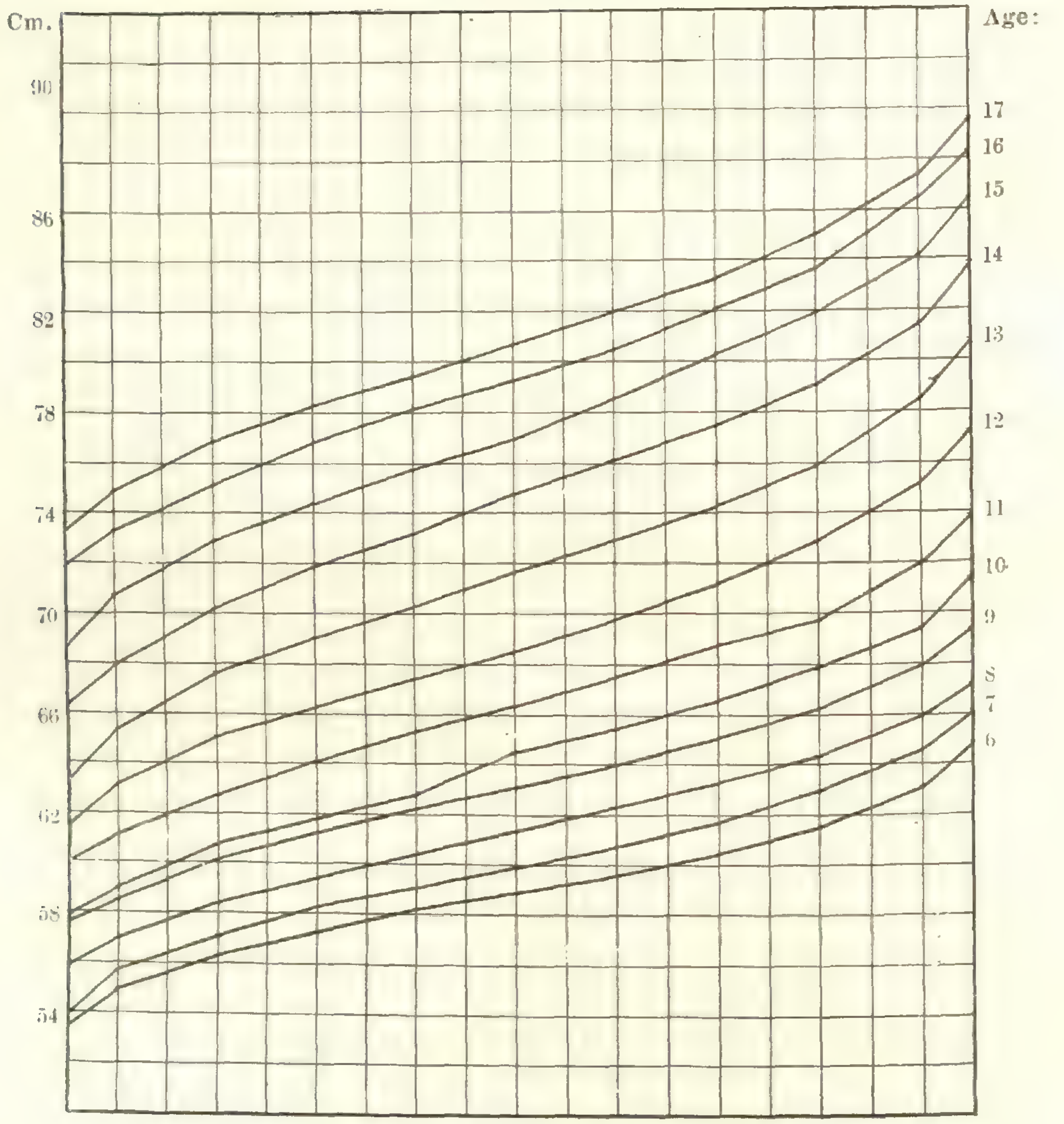
VOL. VI. NO. 12. PLATE XII (from Table No. 20; pages 311, 315).

Girls' Span of Arms.



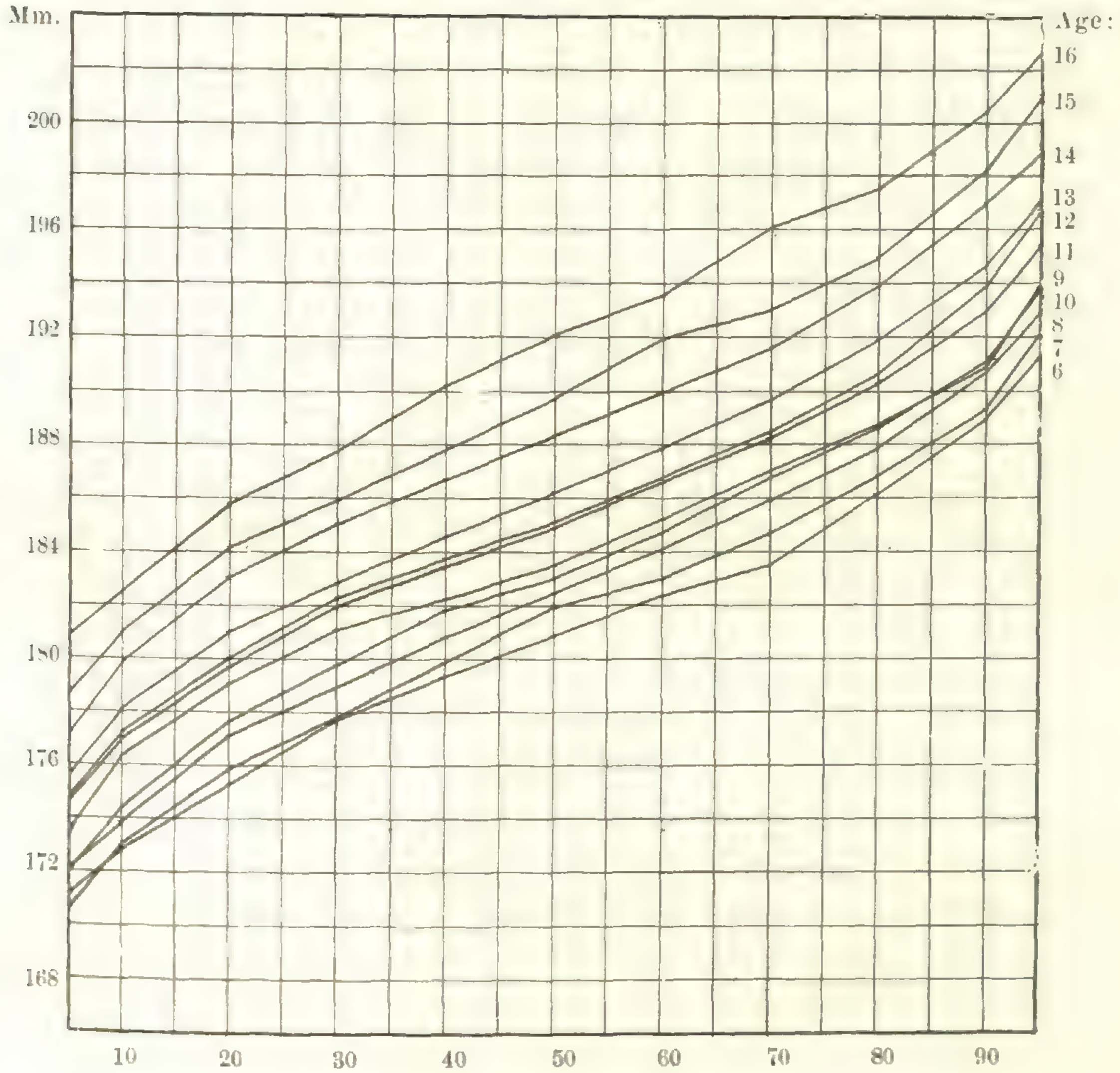
VOL. VI. NO. 12. PLATE XIII (from Table No. 23; pages 311, 818).

Boys' Girth of Chest.



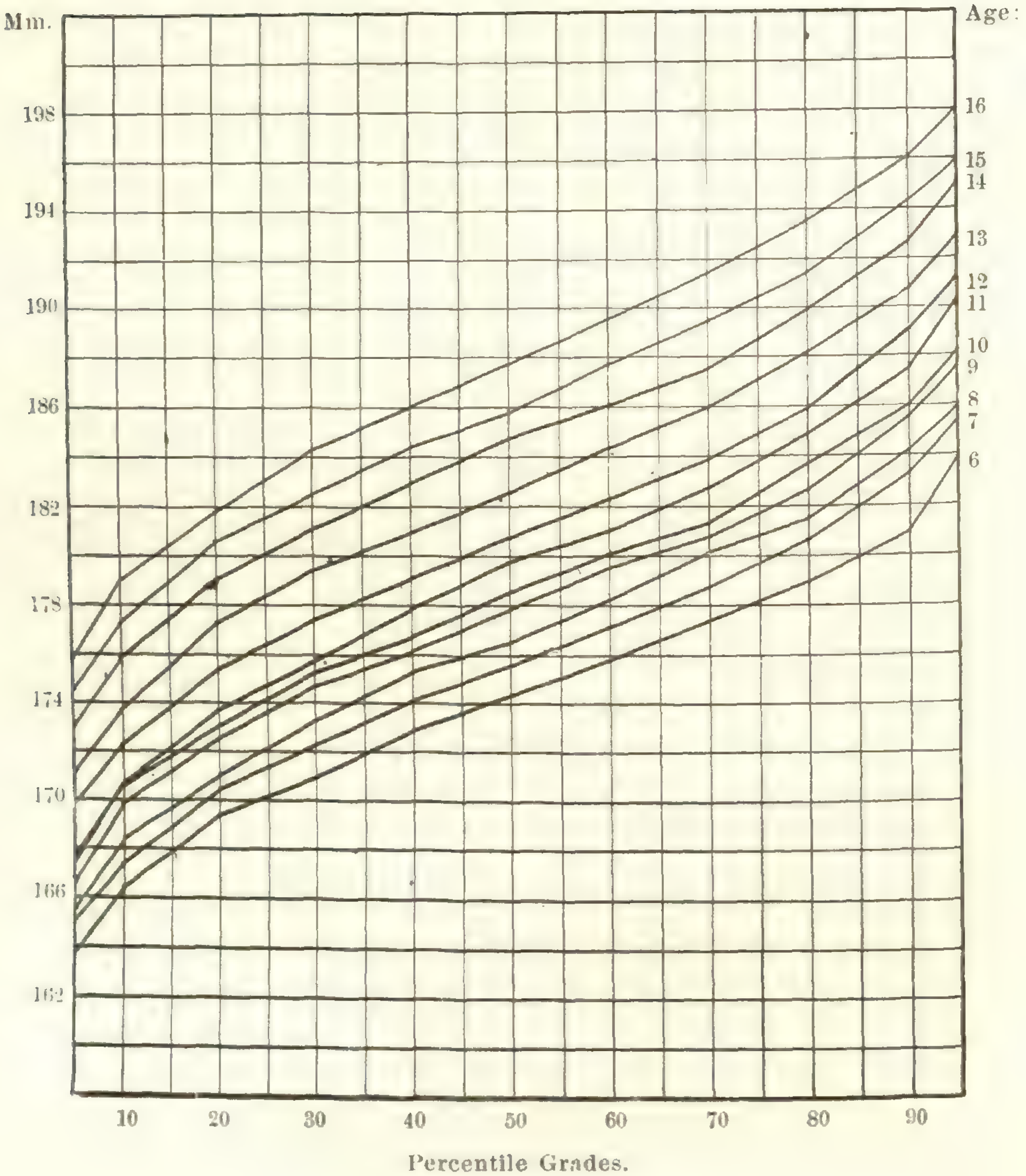
VOL. VI. NO. 12. PLATE XIV (from Table No. 23; pages 311, 318).

Girls' Girth of Chest.



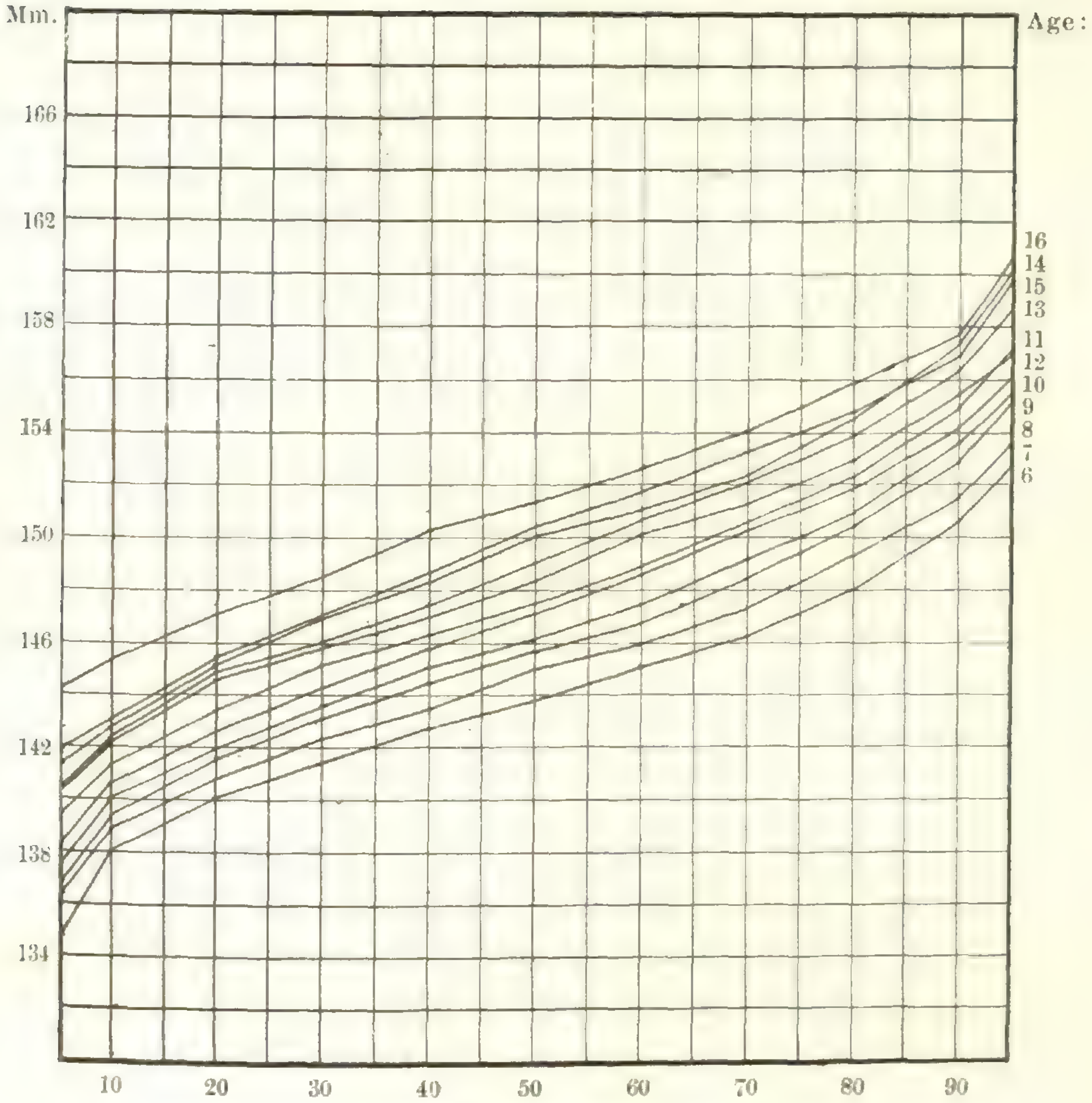
VOL. VI. NO. 12. PLATE XV (from Table No. 24; pages 311, 319).

Boys' Length of Head.



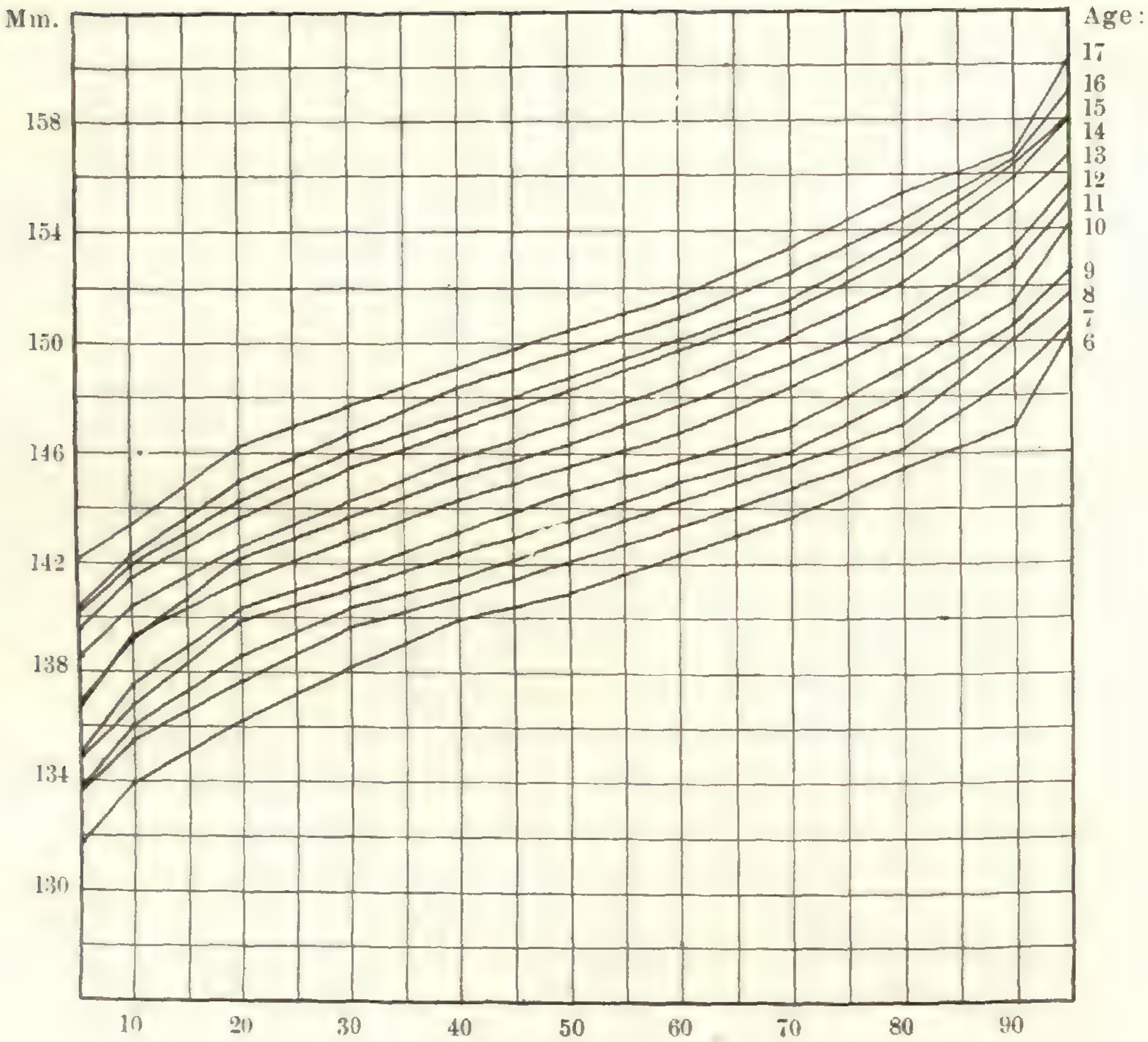
VOL. VI. NO. 12. PLATE XVI (from Table No. 24; pages 311, 319).

Girls' Length of Head.



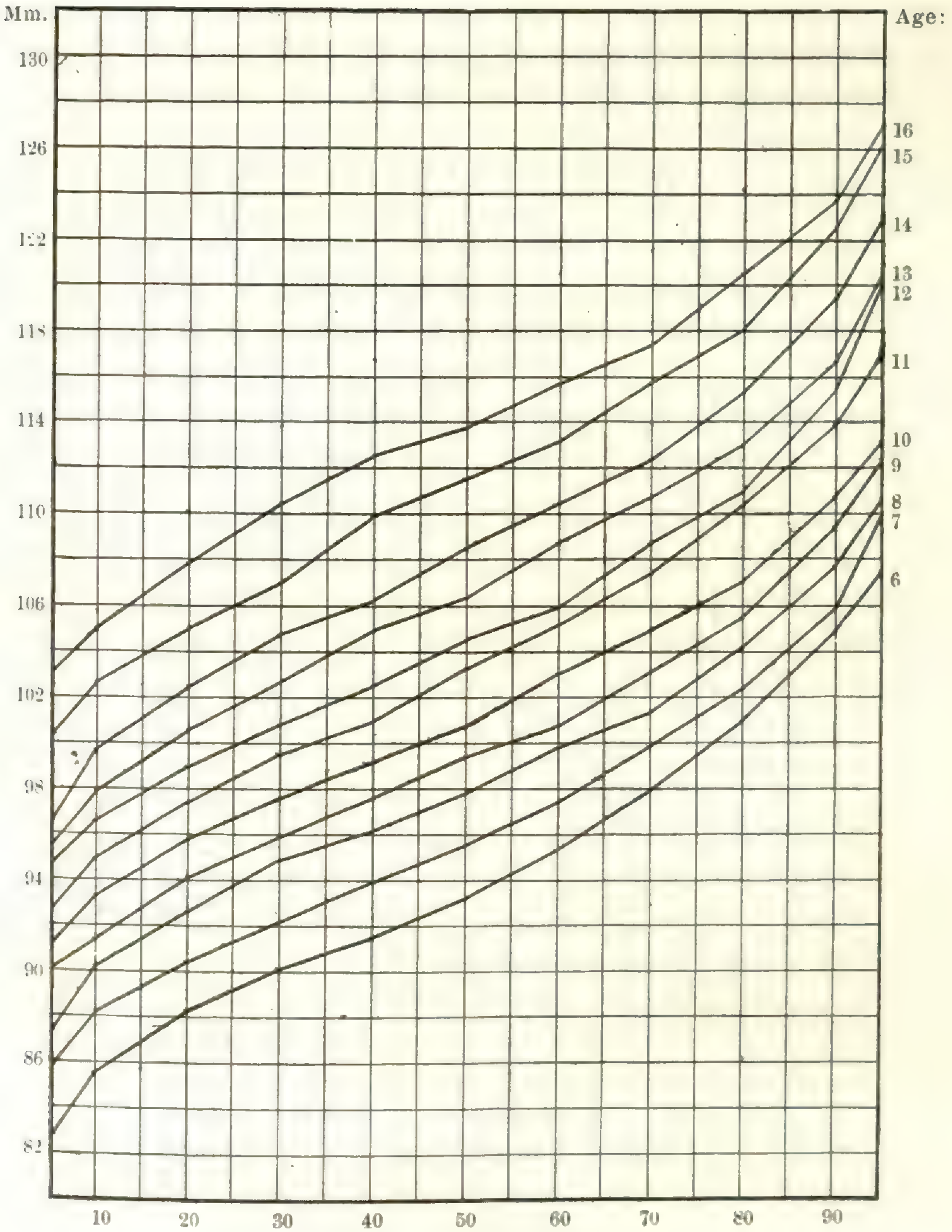
VOL. VI. NO. 12. PLATE XVII (from Table No. 25; pages 311, 320).

Boys' Width of Head.



VOL. VI. No. 12. PLATE XVIII (from Table No. 25; pages 311, 320).

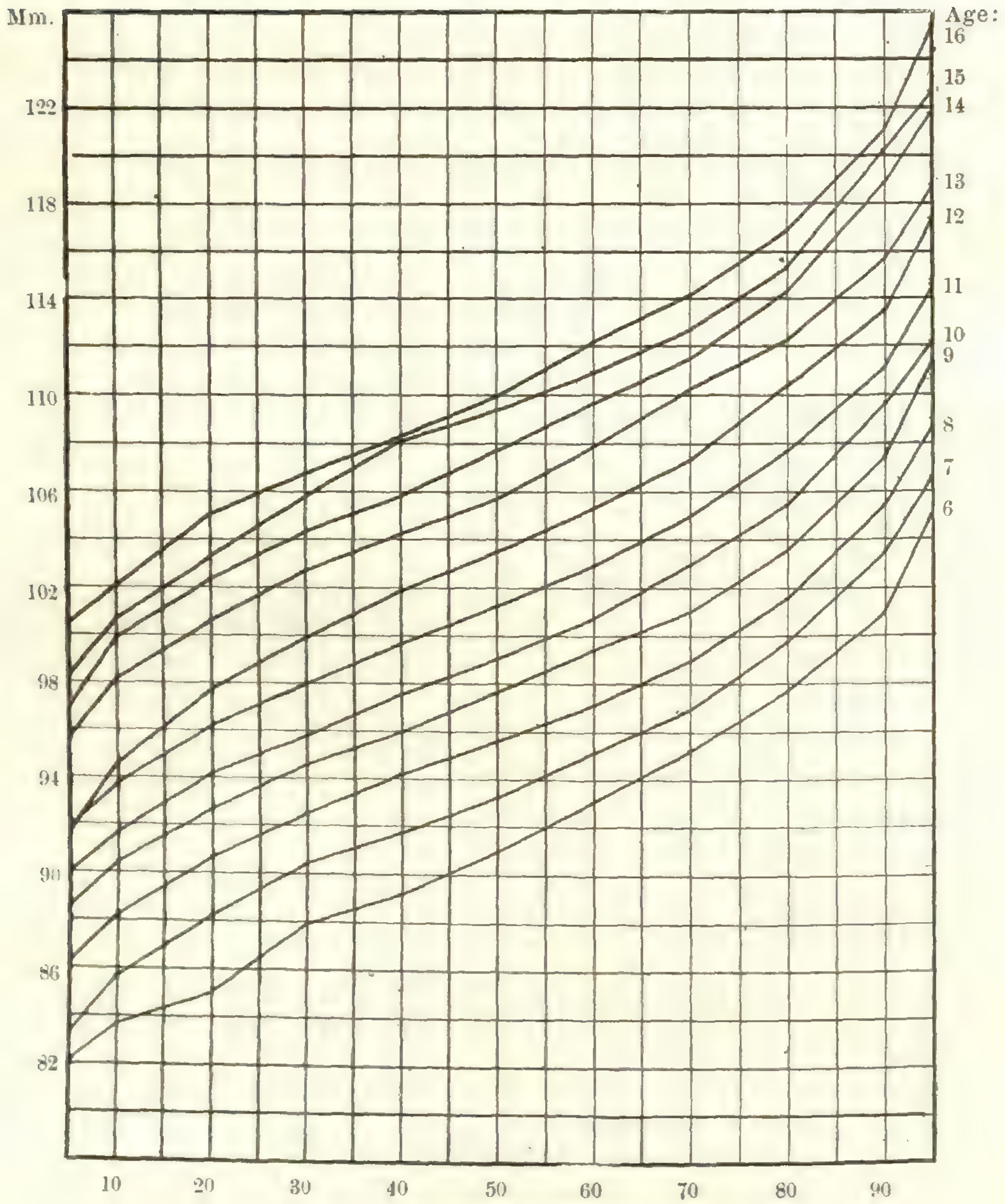
Girls' Width of Head.



Percentile Grades.

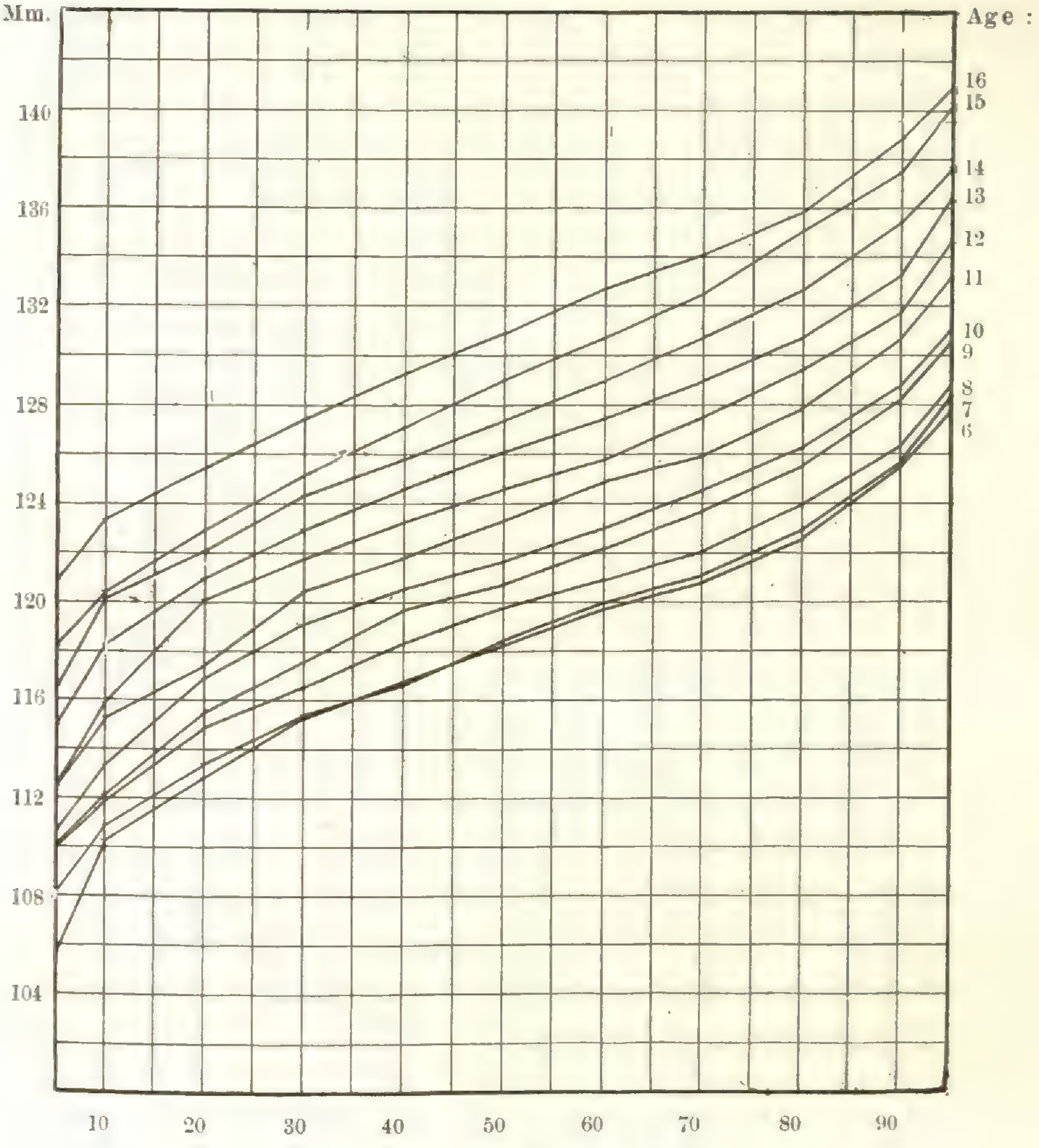
VOL. VI. NO. 12. PLATE XIX (from Table No. 26; pages 311, 321).

Boys' Height of Face from Root of Nose to Point of Chin.



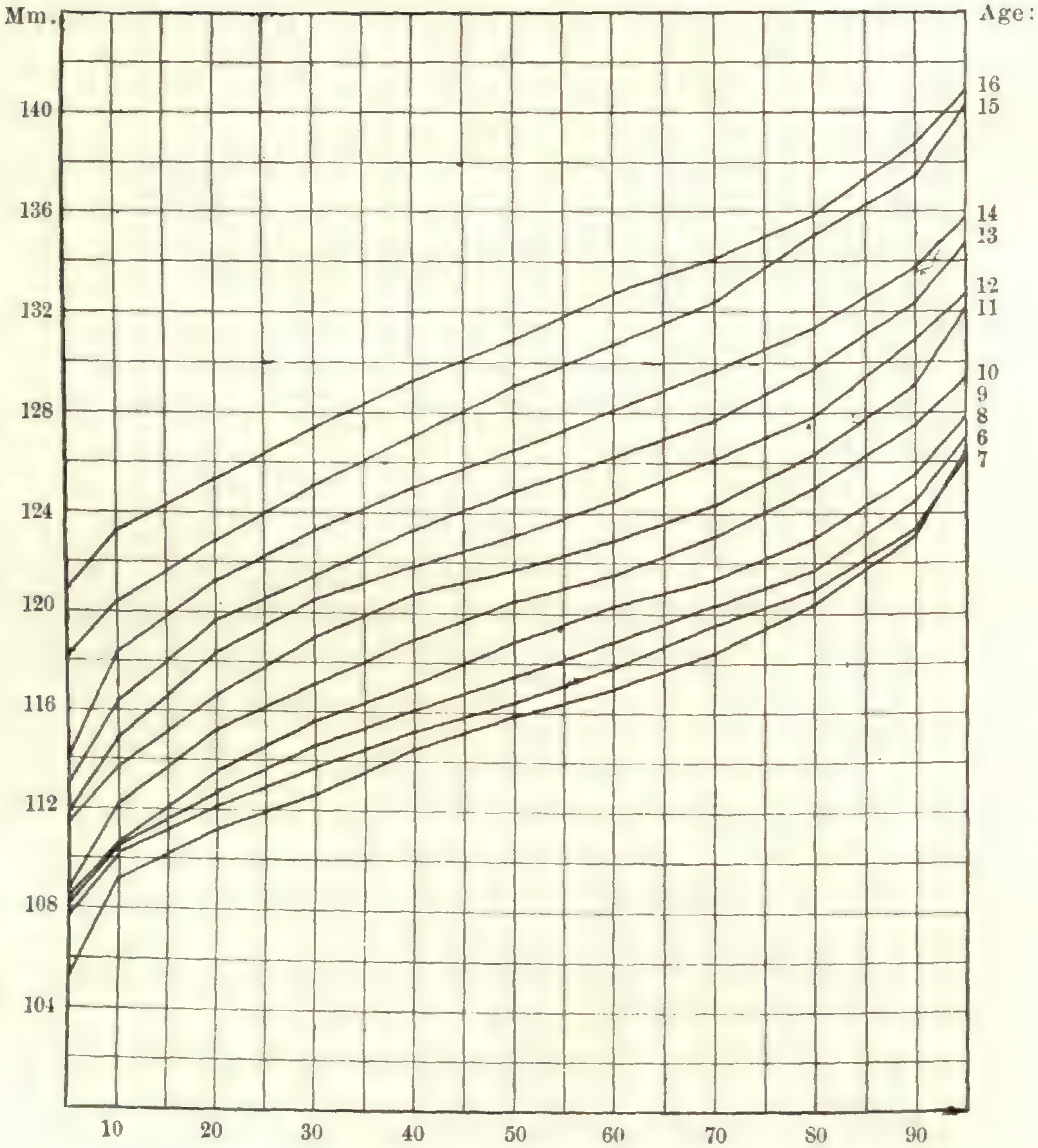
VOL. VI. NO. 12. PLATE XX (from Table No. 26; pages 311, 321).

Girls' Height of Face from Root of Nose to Point of Chin.



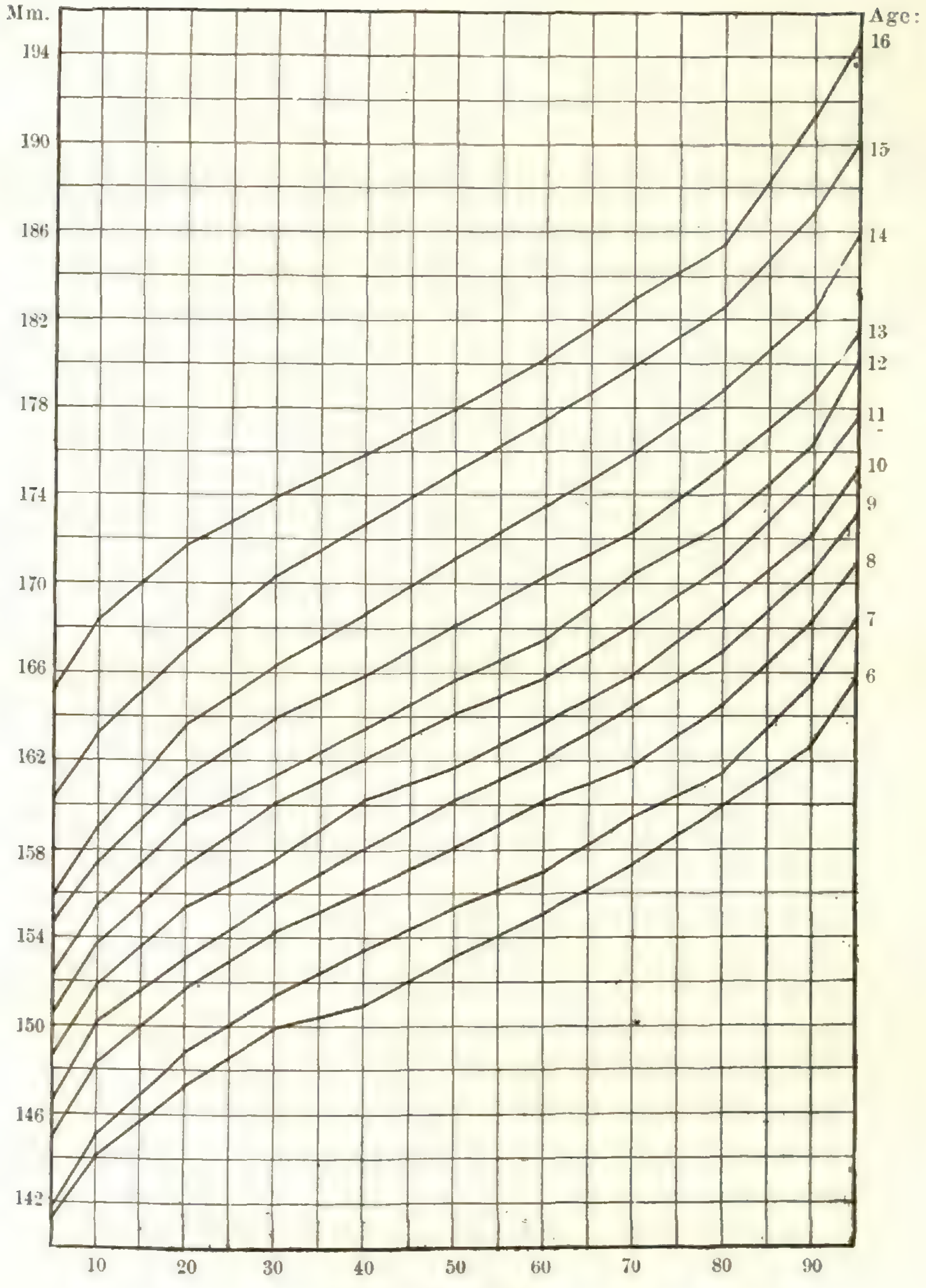
VOL. VI. NO. 12. PLATE XXI (from Table No. 27; pages 311, 322).

Boys' Width of Face.



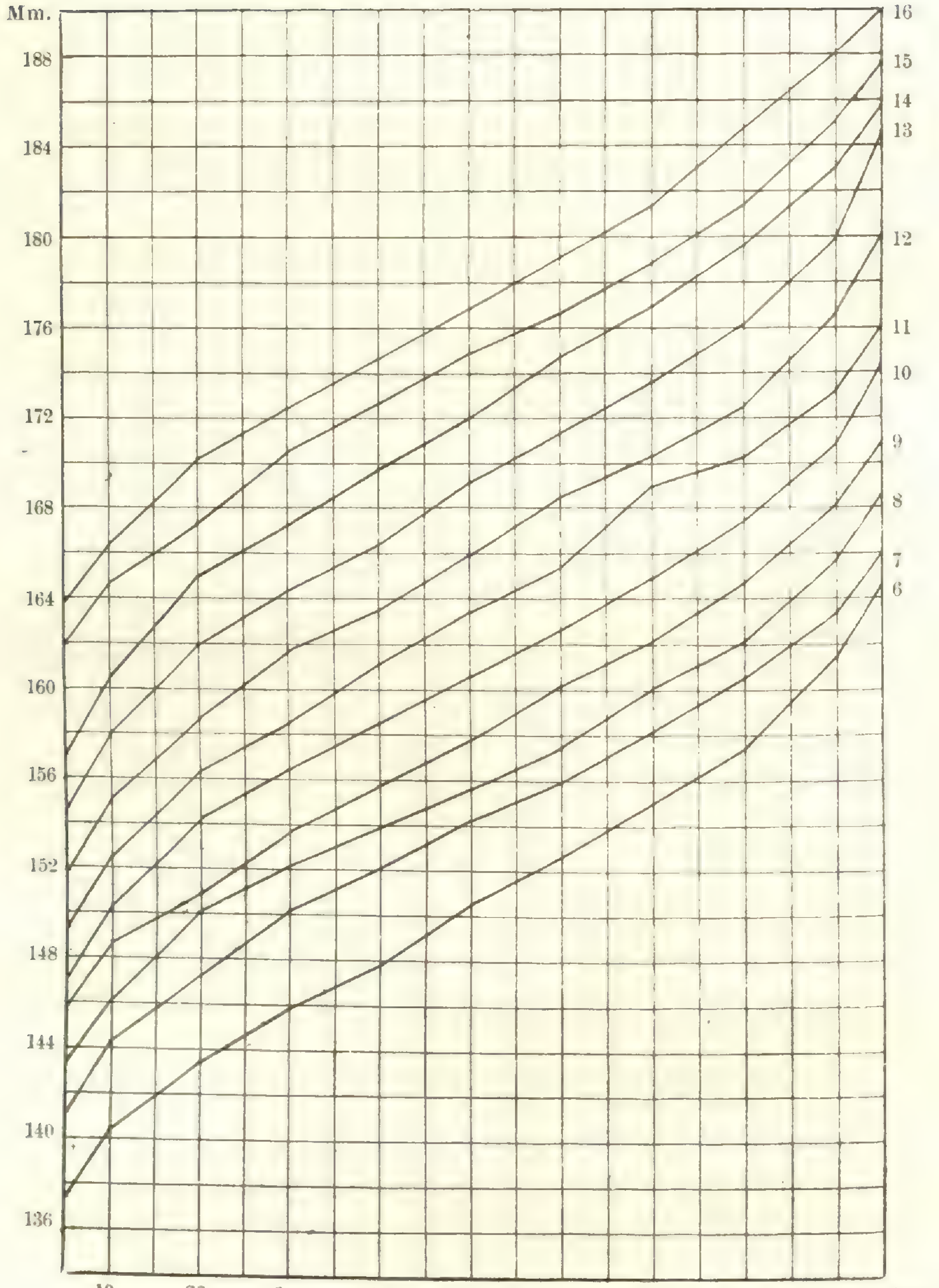
VOL. VI. NO. 12. PLATE XXII (from Table No. 27; page 322).

Girls' Width of Face.



VOL. VI. NO. 12. Plate XXIII (from Table No. 28; pages 311, 323).

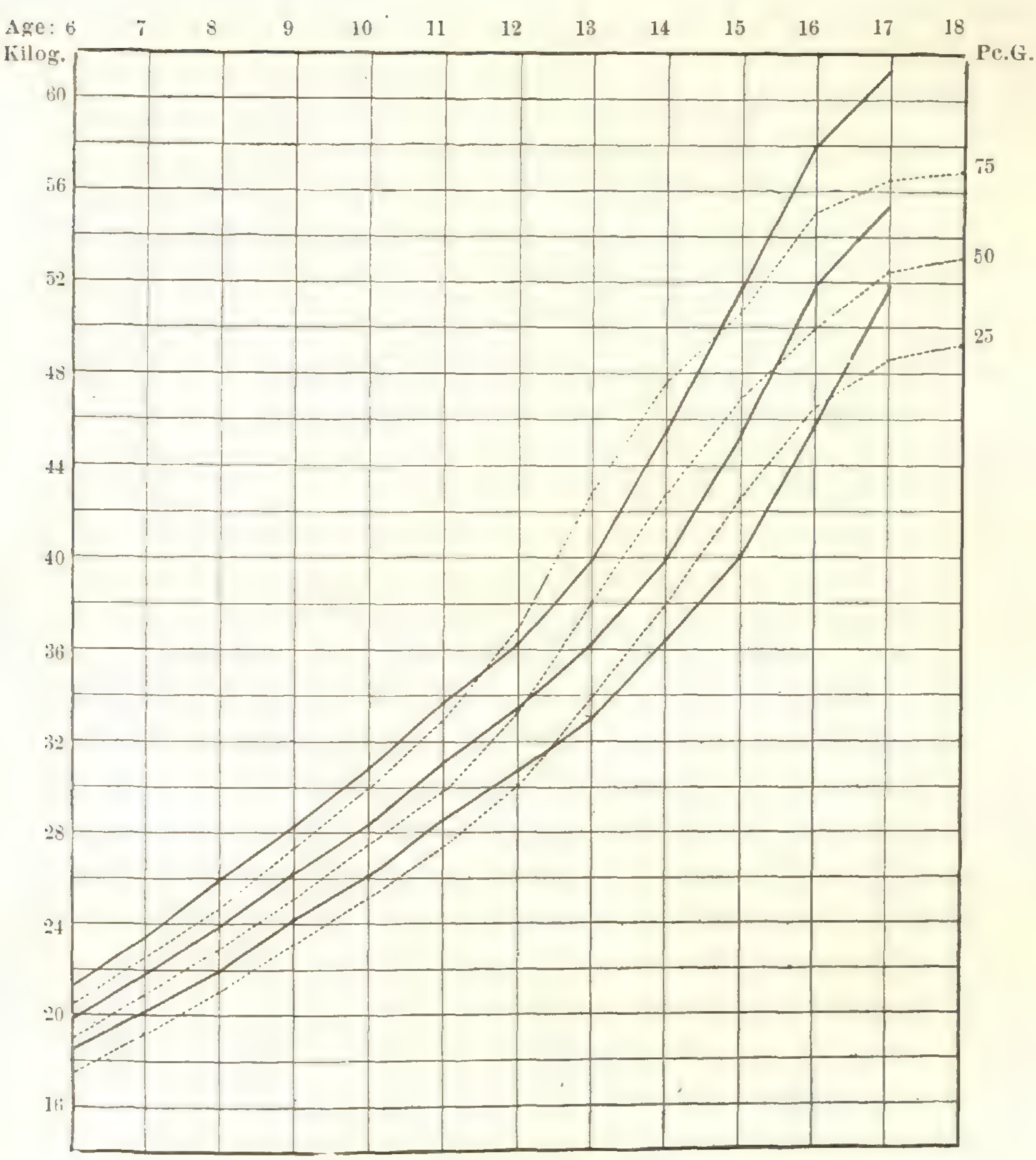
Boys' Height of Face from Hair-Line to Point of Chin.



Percentile Grades.

VOL. VI. NO. 12. PLATE XXIV (from Table No. 28; pages 311, 323).

Girls' Height of Face From Hair-Line to Point of Chin.

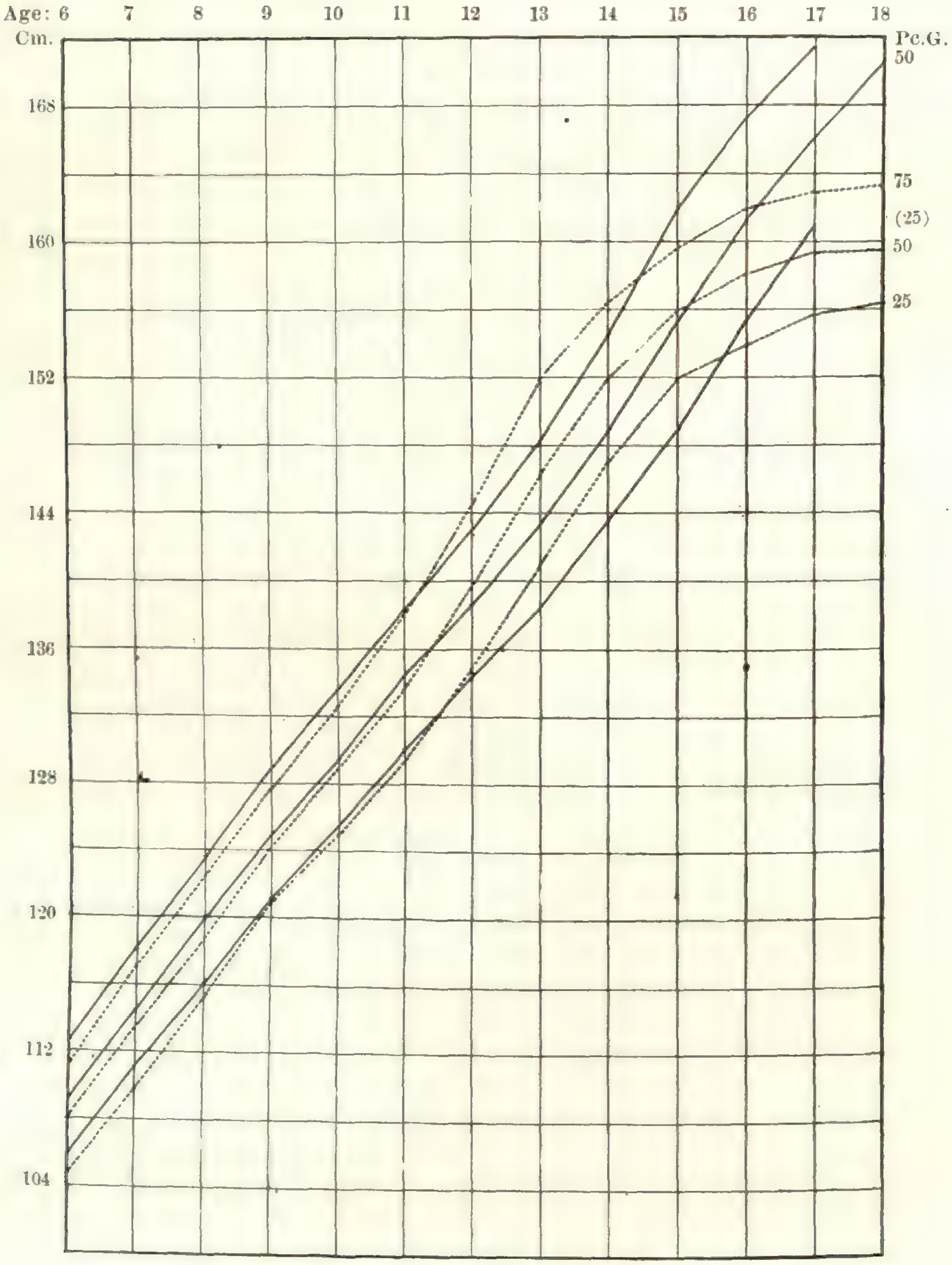


VOL. VI. NO. 12. PLATE XXV (from Table No. 39; pages 324, 351).

Weight.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. Girls: Broken Lines.

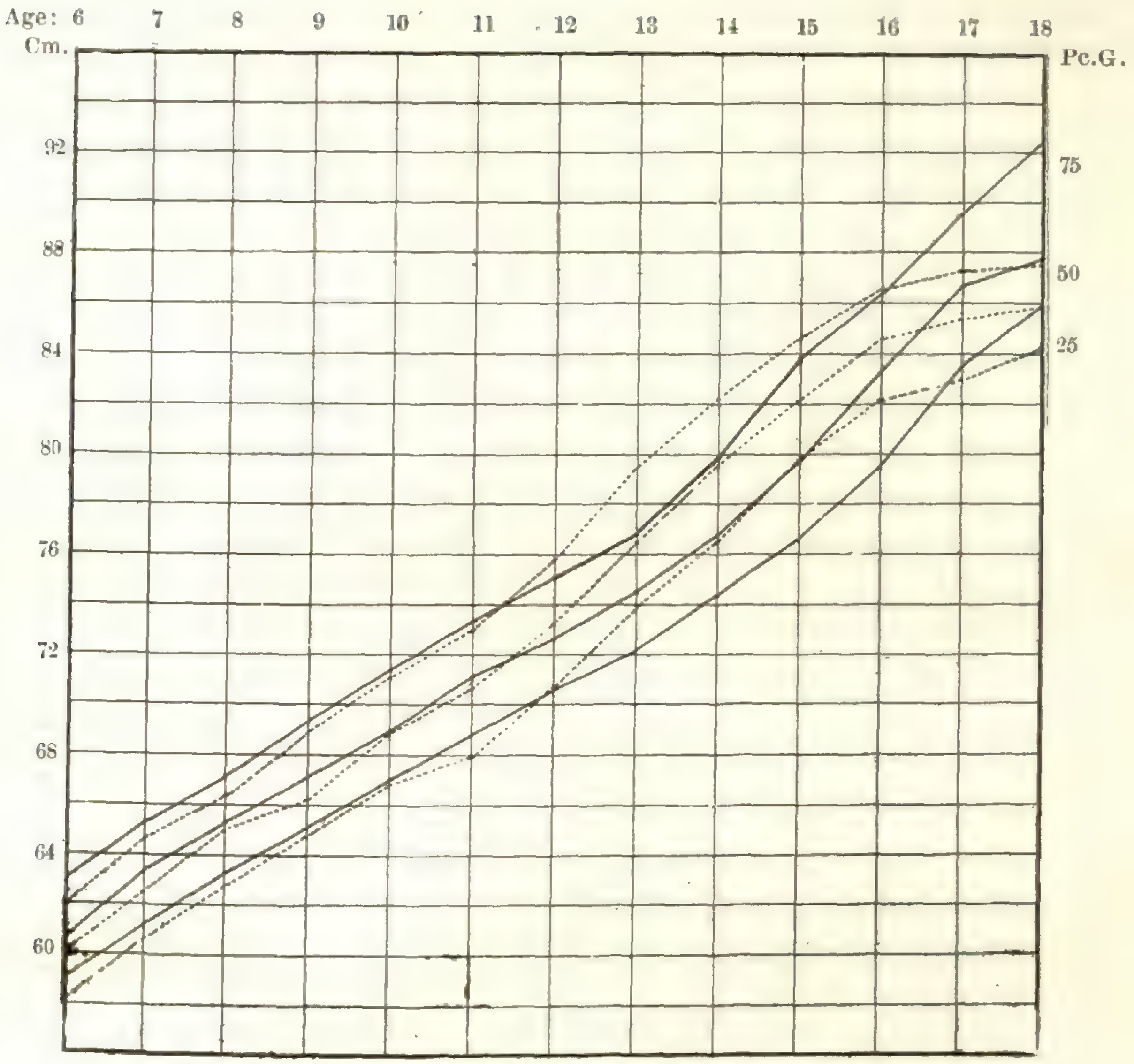


VOL. VI. NO 12. PLATE XXVI (from Table No. 38; pages 324, 350).

Height Standing.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. **Girls: Broken Lines.**

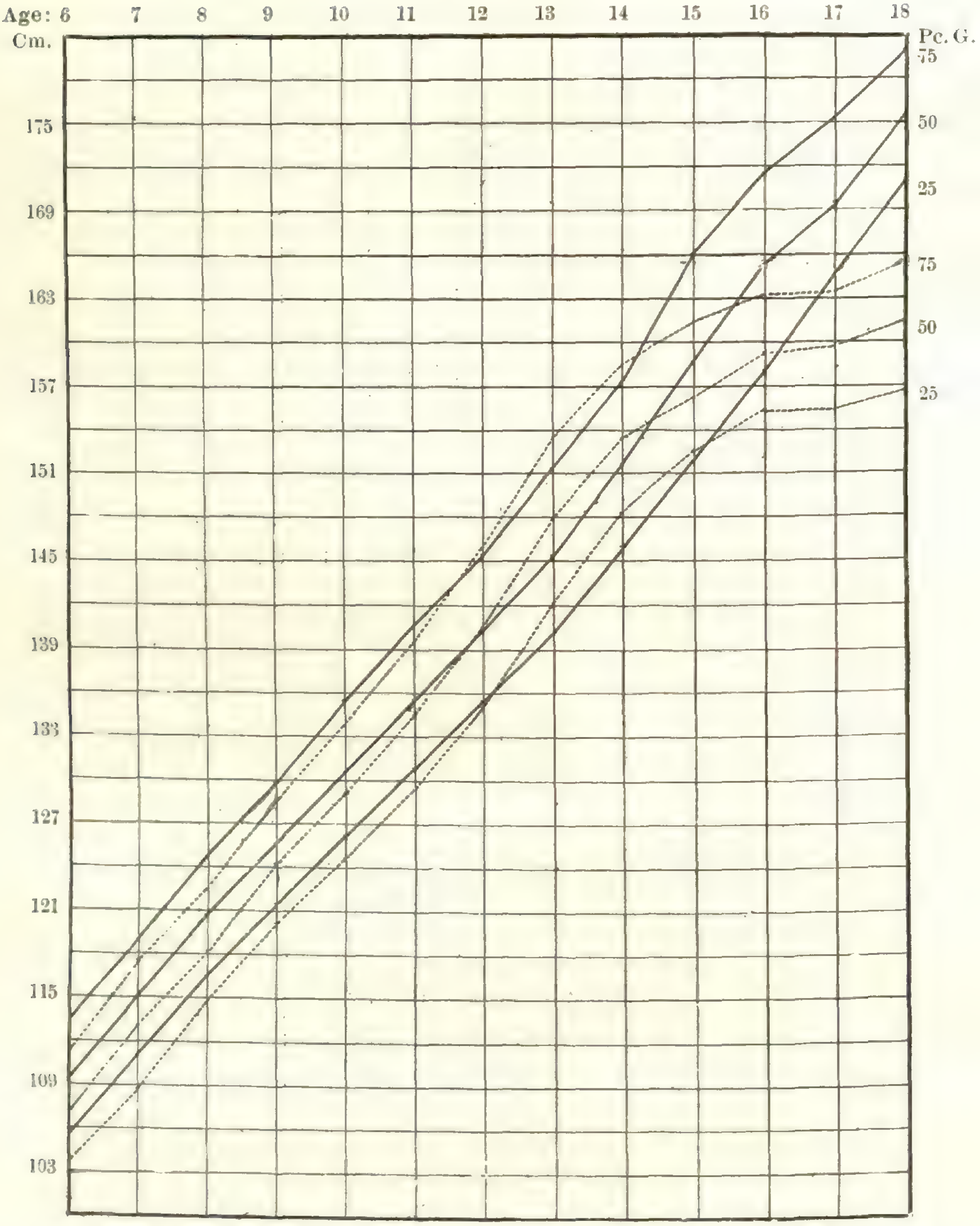


VOL. VI. NO. 12. PLATE XXVII (from Table No. 40; pages 324, 352).

Height Sitting.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. **Girls: Broken Lines.**

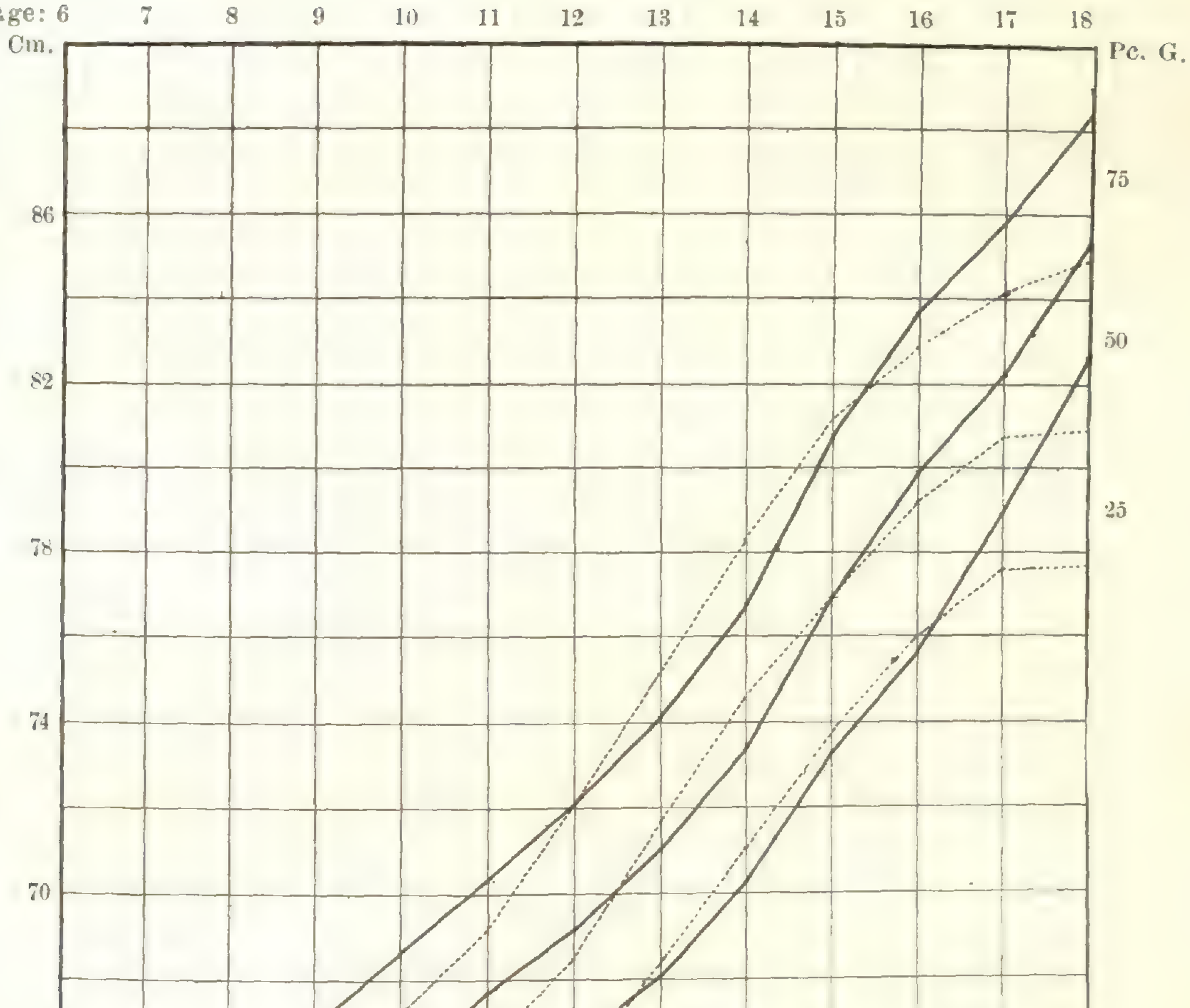


VOL. VI. NO. 12. PLATE XXVIII (from Table No. 41; pages 324, 353).

Span of Arms.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. Girls: Broken Lines.

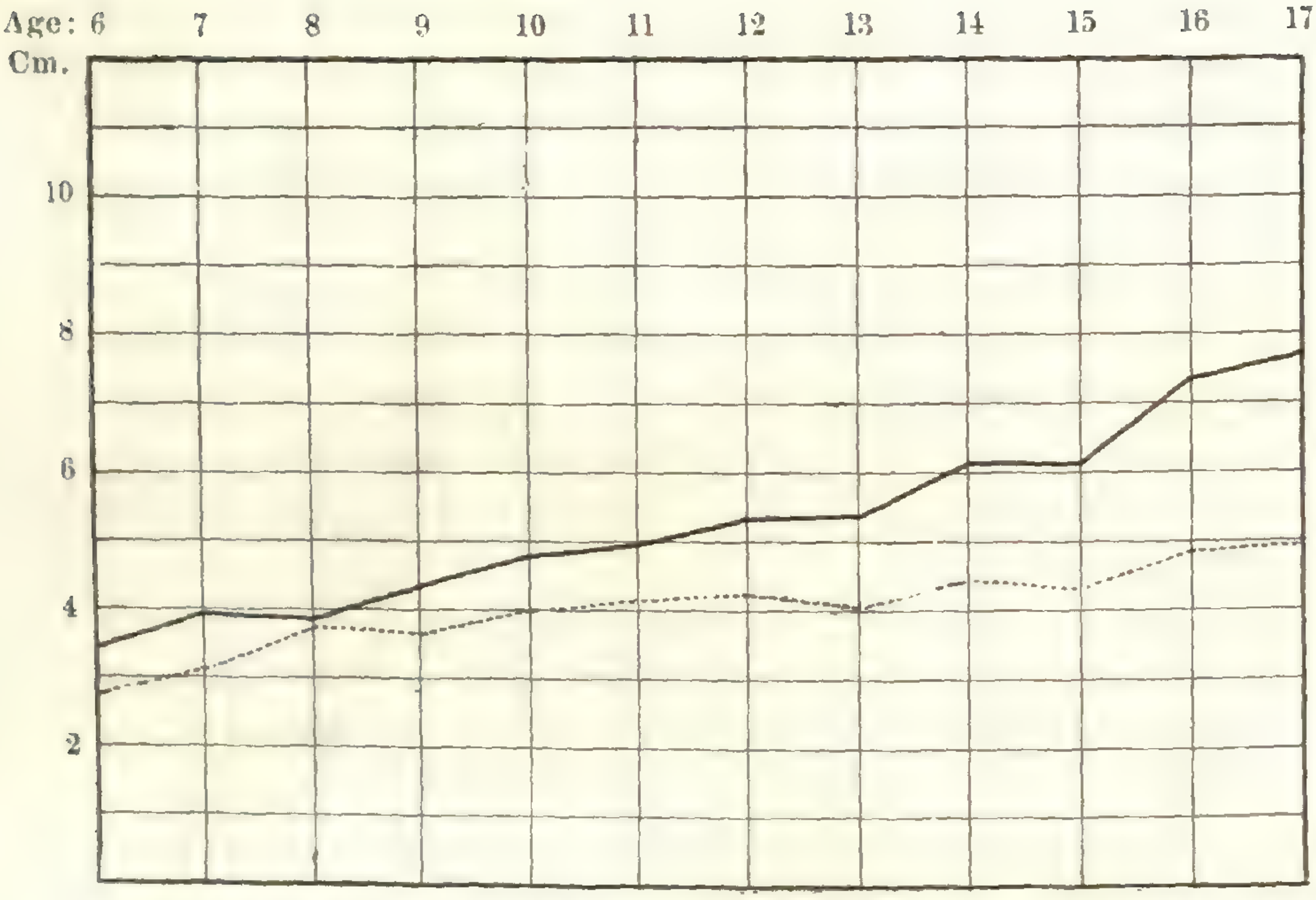


VOL. VI. NO. 12. PLATE XXIX (from Table No. 42; pages 324, 354).

Girth of Chest.

75, 50 and 25 Percentile Grades.

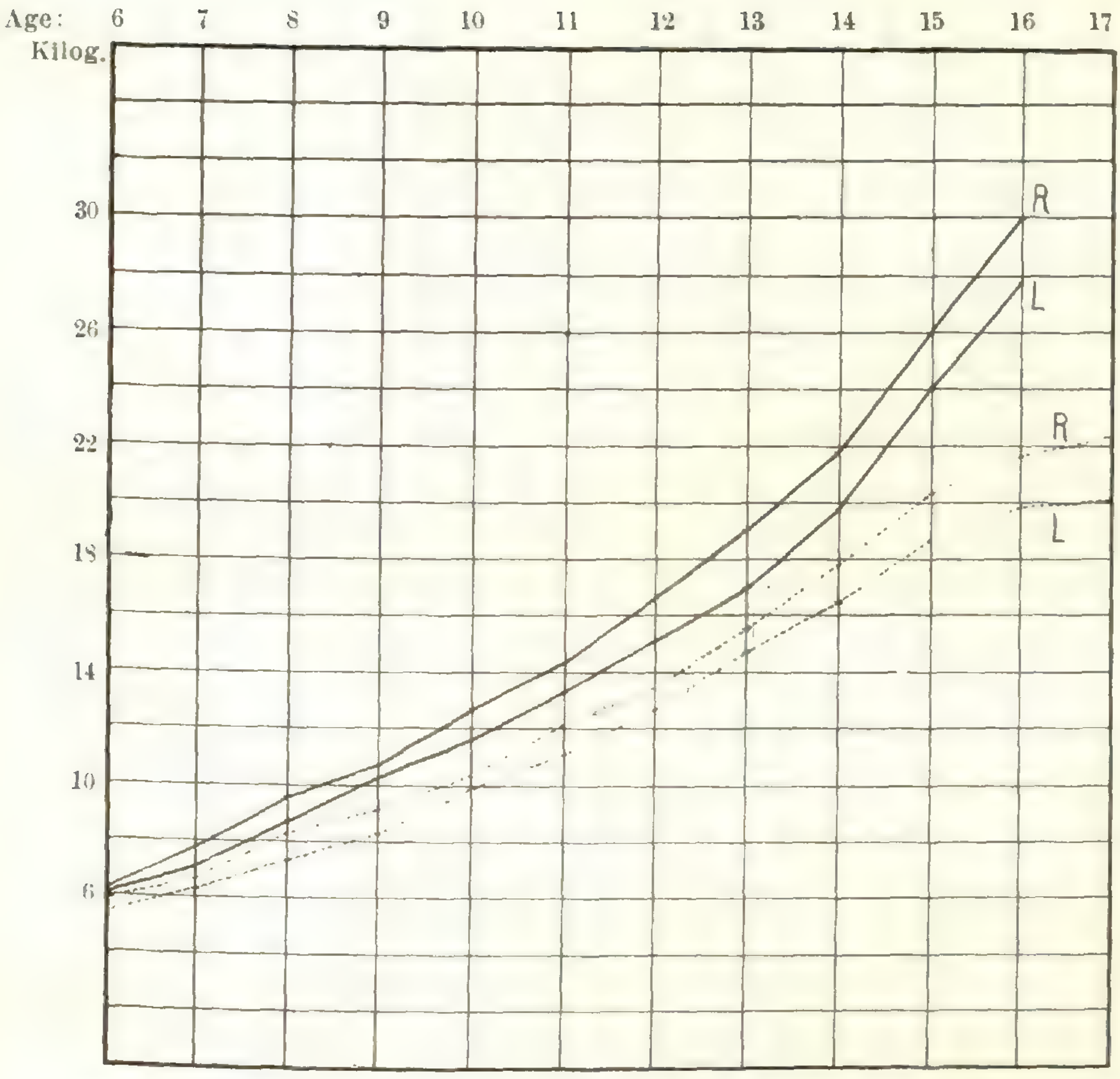
Boys: Unbroken Lines. Girls: Broken Lines.



VOL. VI. NO. 12. PLATE XXX (from Tables No. 21, 22; pages 316, 317, 325).

Mean Expansion of Chest.

Boys: Unbroken Lines. **Girls: Broken Lines.**

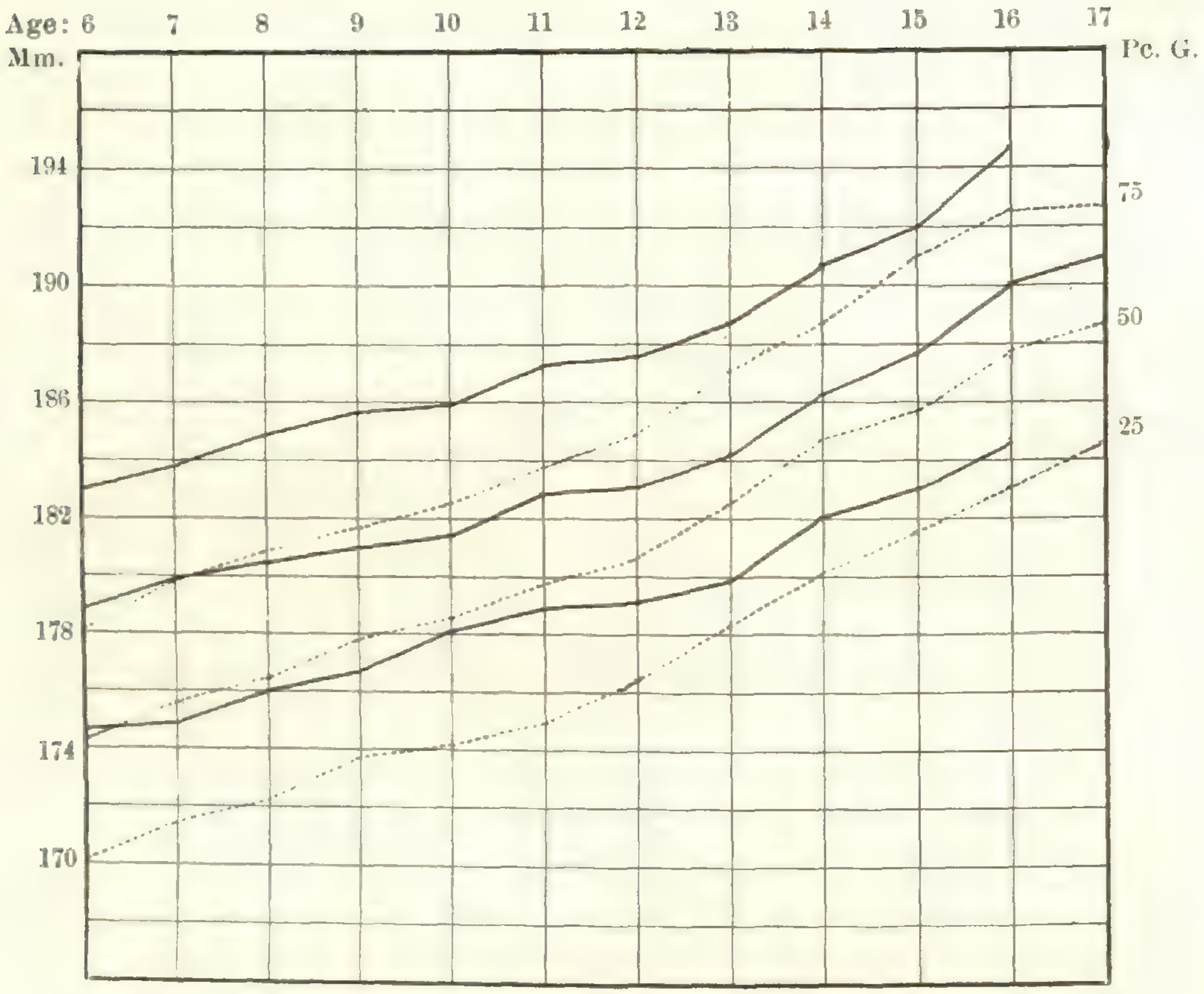


VOL. VI. NO. 12. PLATE XXXI (from Tables No. 43, 44; pages 325, 355, 356).

Mean Strength of Squeeze.

R: Right Hand. L: Left Hand.

Boys: Unbroken Lines. Girls: Broken Lines.

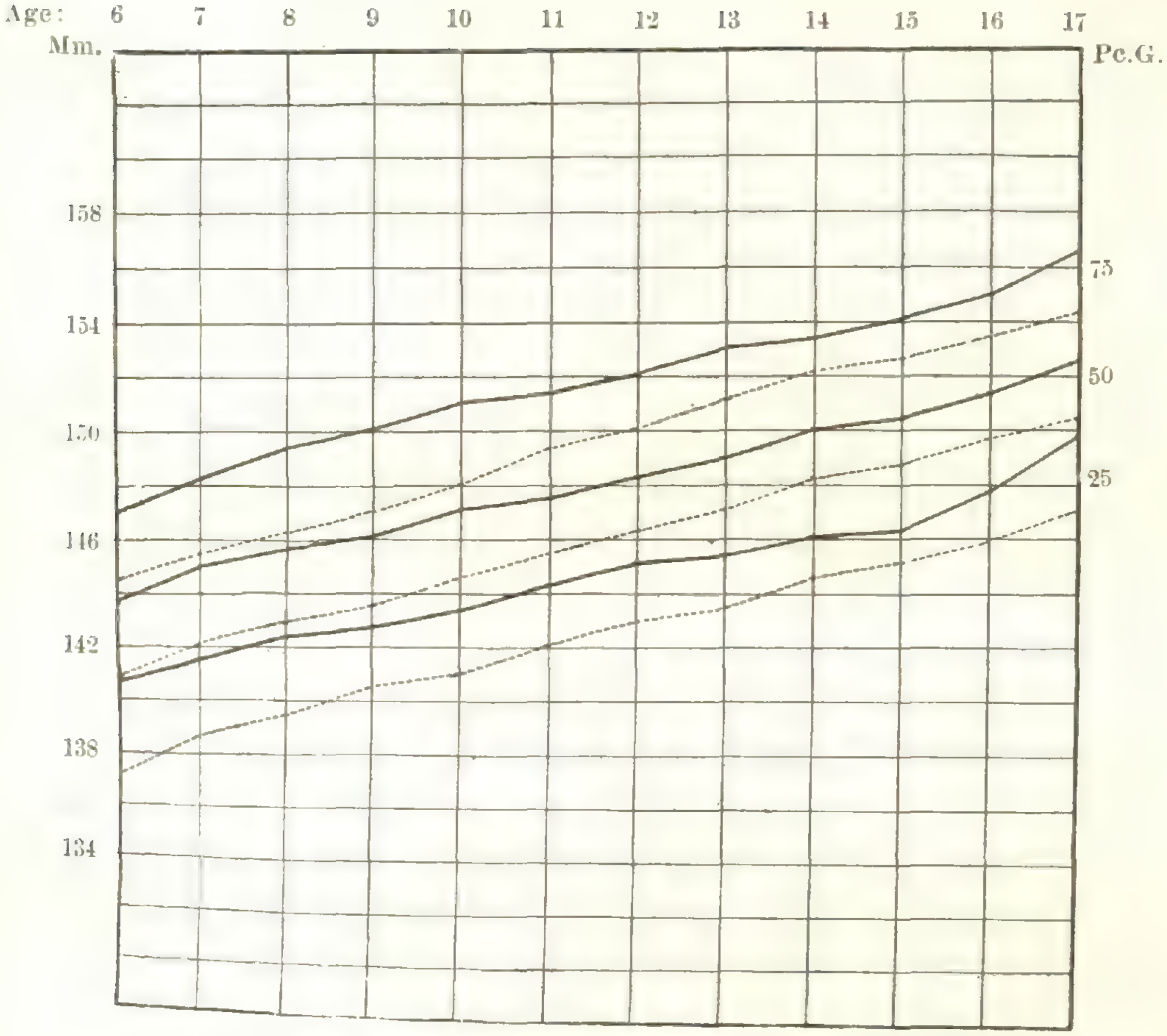


VOL. VI. NO. 12. PLATE XXXII (from Table No. 47; pages 325, 359).

Length of Head.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. Girls: Broken Lines.

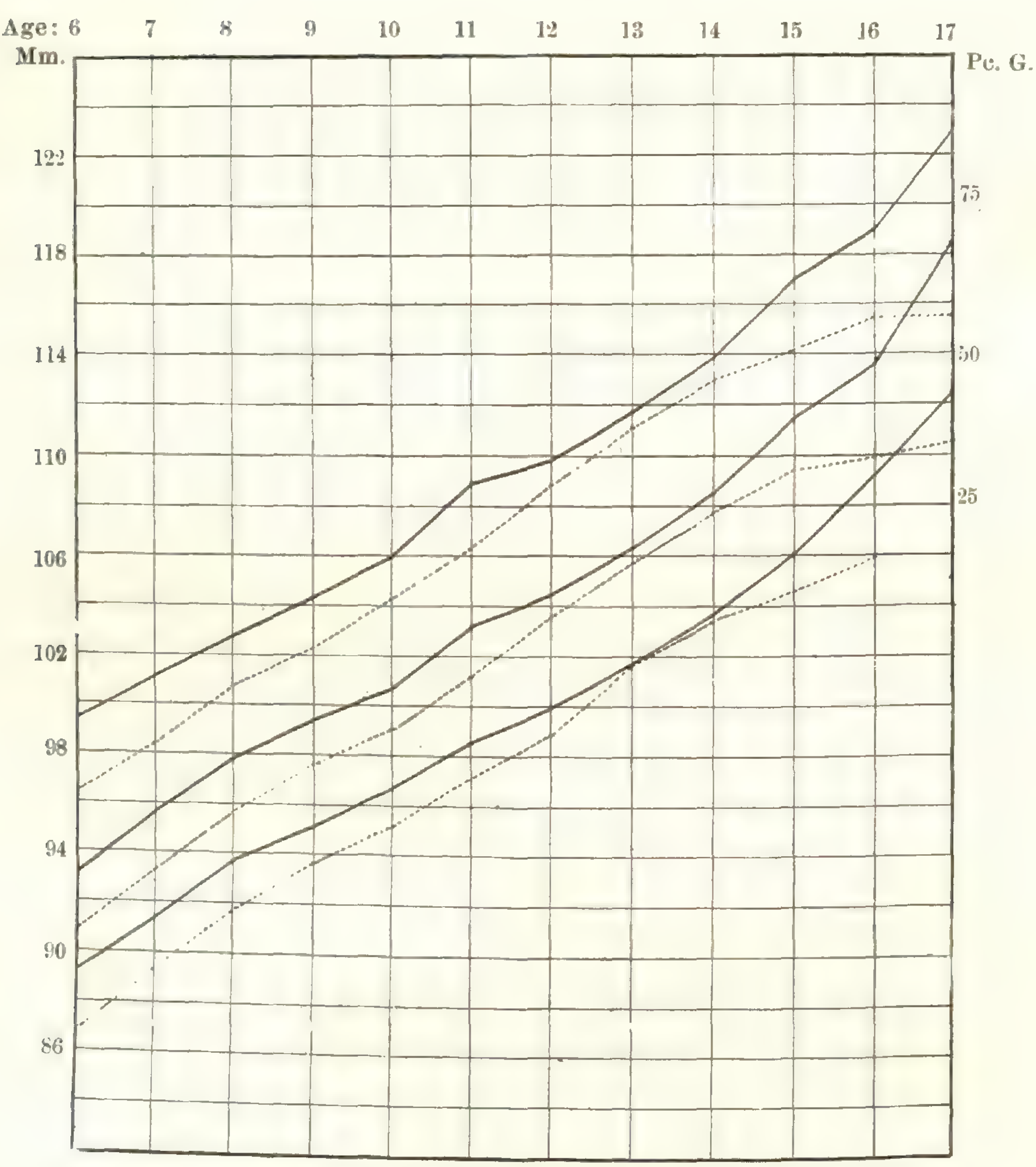


VOL. VI. NO. 12. PLATE XXXIII (from Table No. 48; pages 325, 360).

Width of Head.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. **Girls: Broken Lines.**

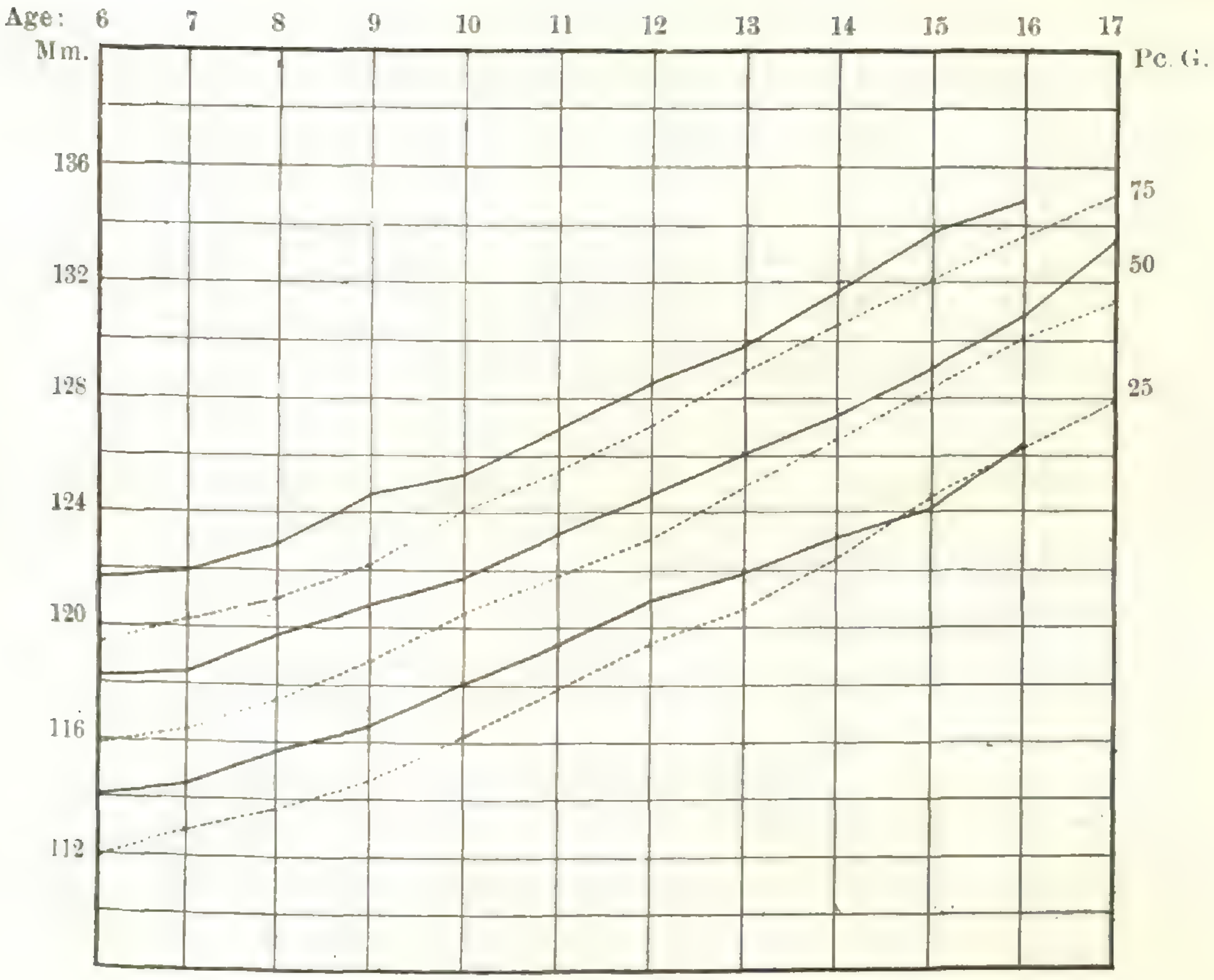


VOL. VI. NO. 12. PLATE XXXIV (from Table No. 49; pages 325, 361).

Height of Face from Root of Nose to Point of Chin.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. **Girls: Broken Lines.**

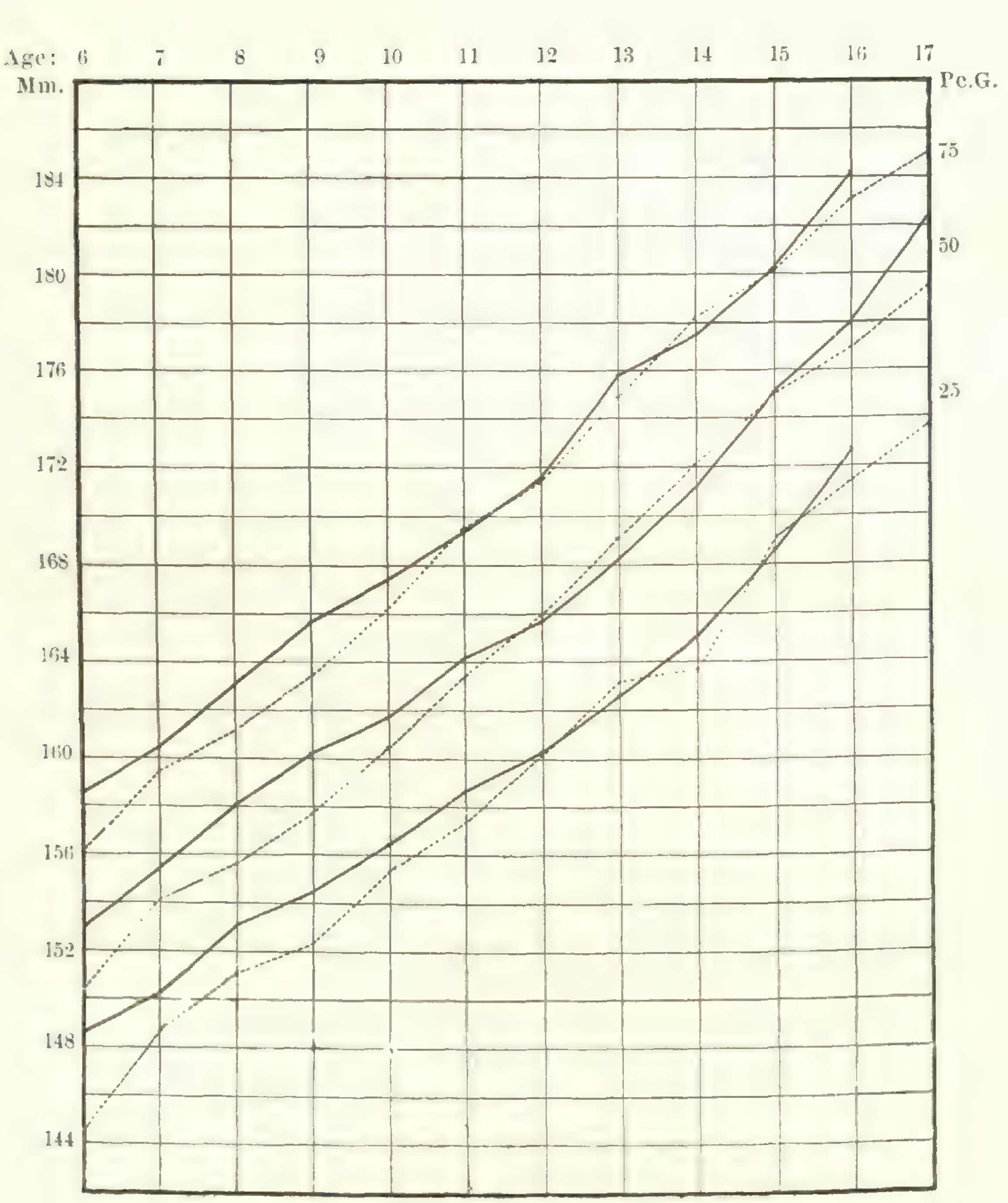


VOL. VI. NO. 12. PLATE XXXV (from Table No. 50; pages 325, 362).

Width of Face.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. Girls: Broken Lines.

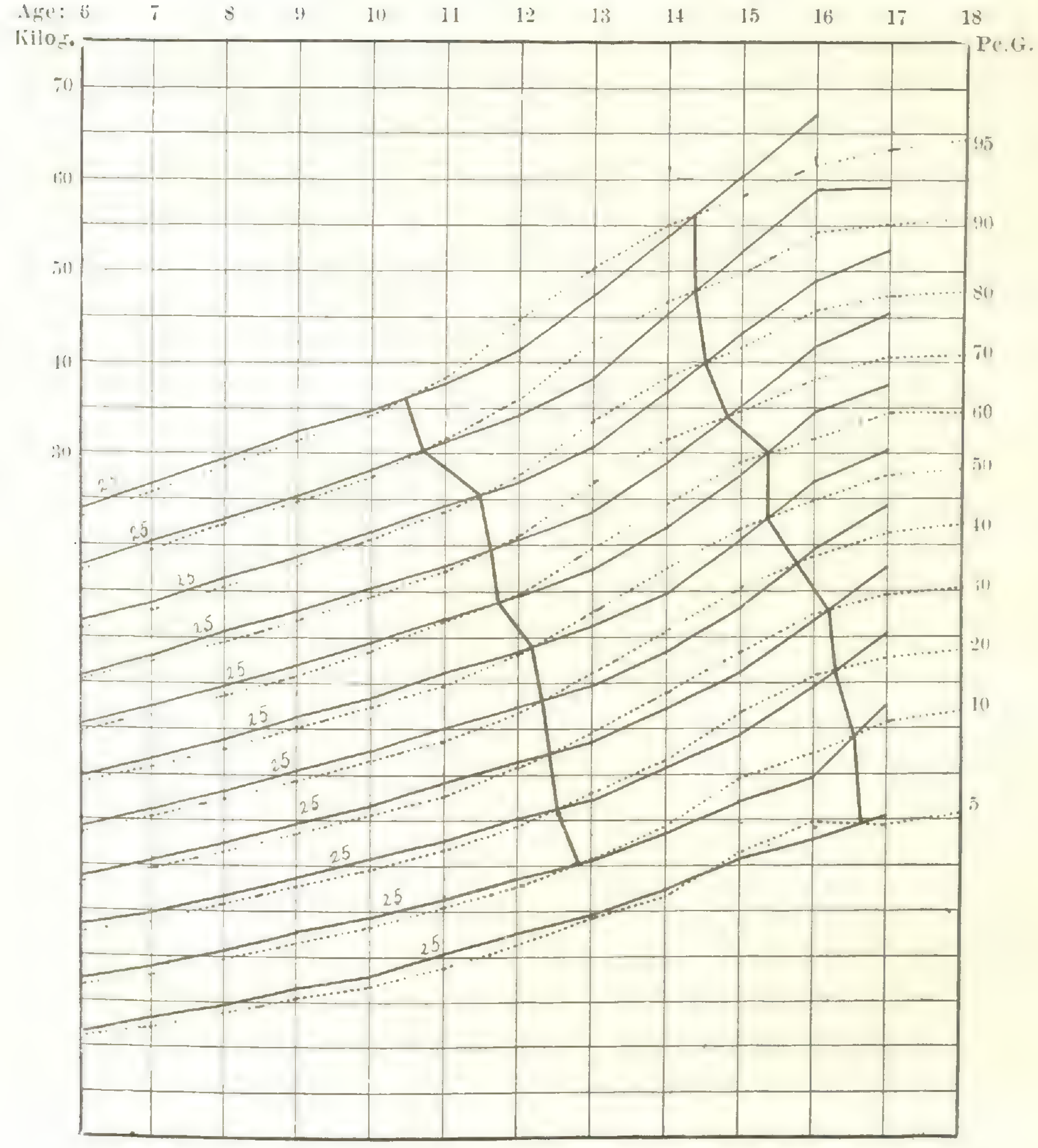


VOL. VI. NO. 12. PLATE XXXVI (from Table No. 51; pages 325, 363).

Height of Face from Hair-Line to Point of Chin.

75, 50 and 25 Percentile Grades.

Boys: Unbroken Lines. Girls: Broken Lines.

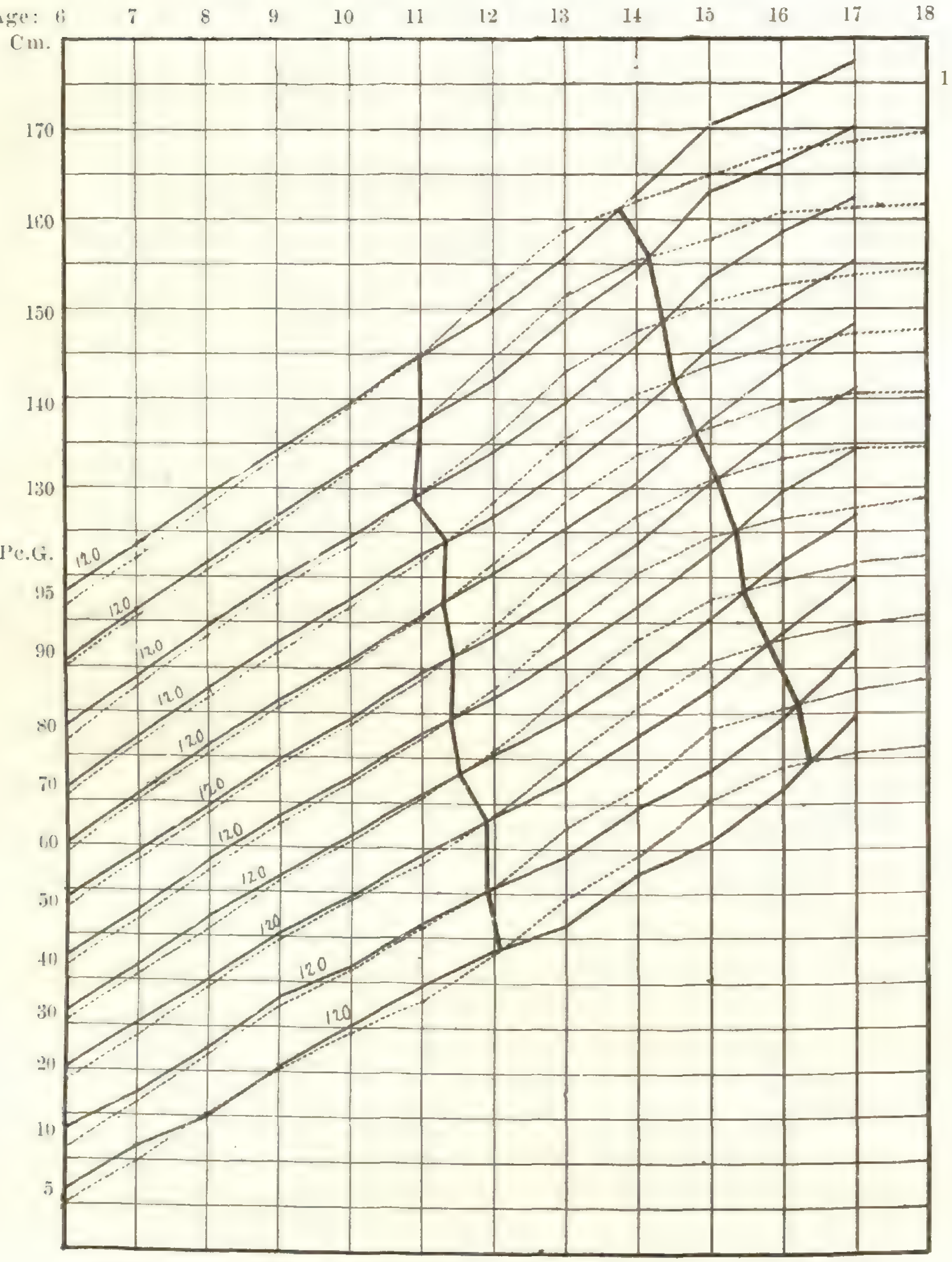


VOL. VI. NO. 12. PLATE XXXVII (from Table No. 17; pages 312, 325).

Percentile Grades.

Weight.

Boys: Unbroken Lines. **Girls: Broken Lines.**

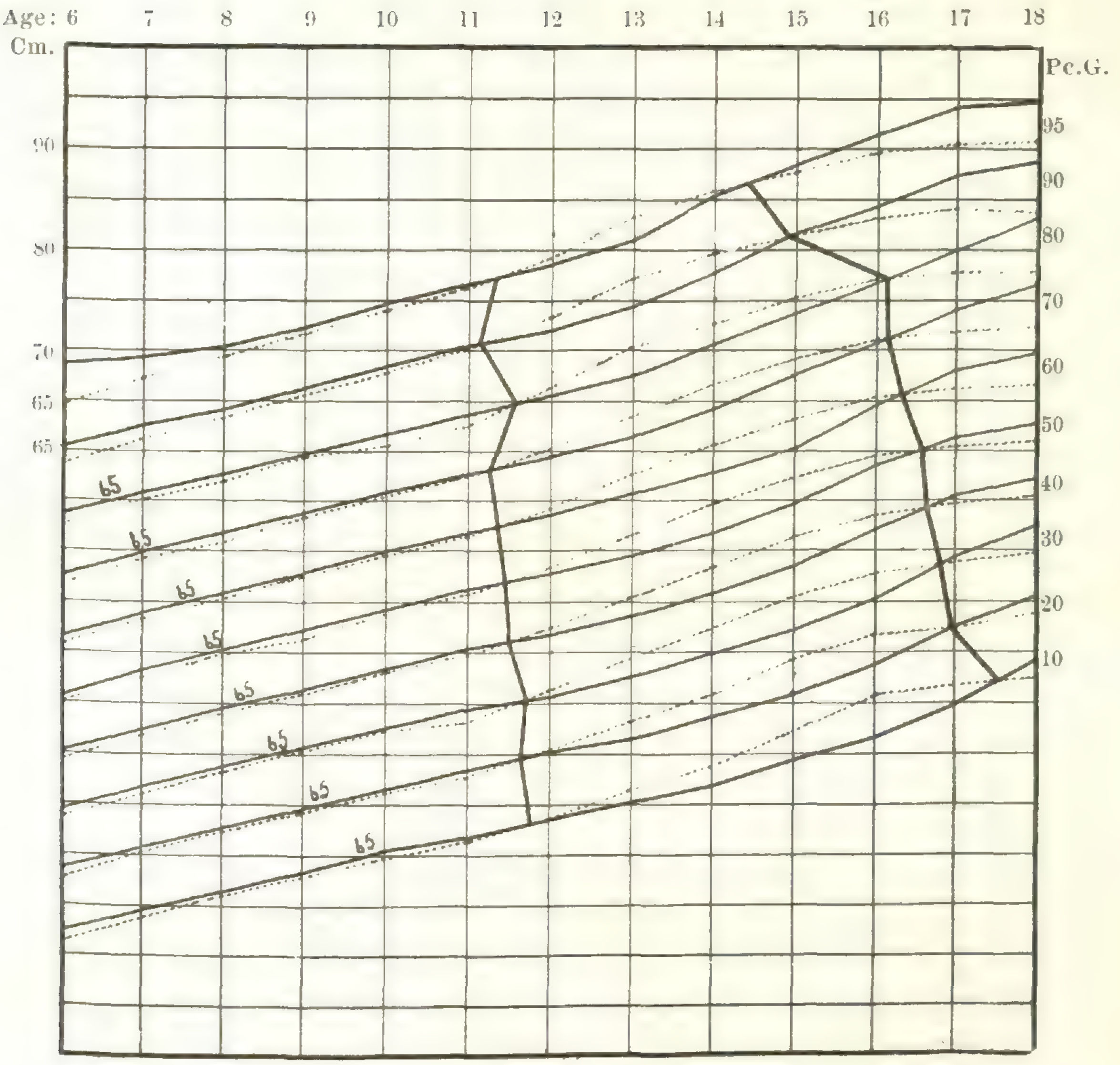


VOL. VI. NO. 12. PLATE XXXVIII (from Table No. 18; pages 313, 325).

Percentile Grades.

Height Standing.

Boys: Unbroken Lines. Girls: Broken Lines.

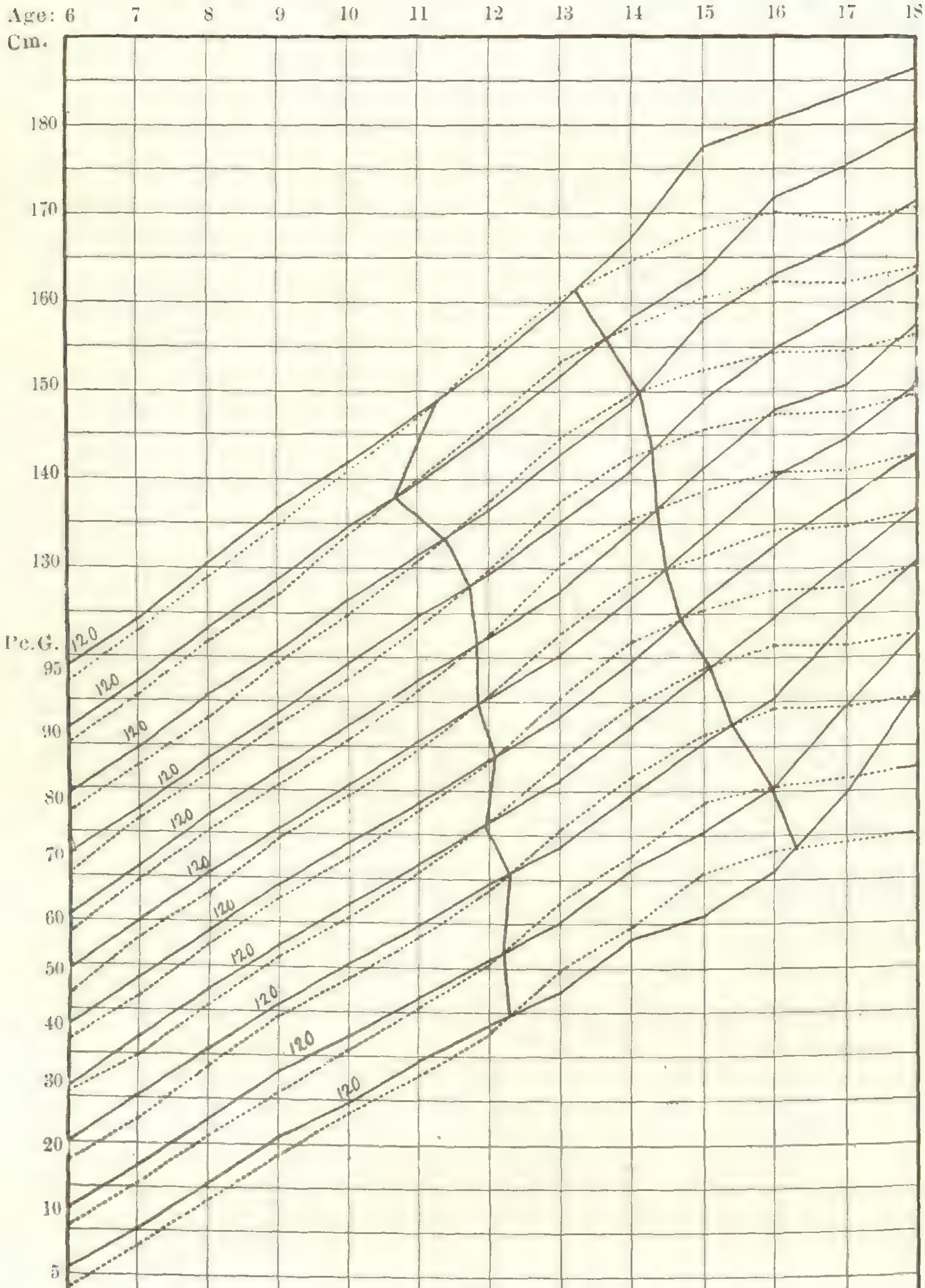


VOL. VI. NO. 12. PLATE XXXIX (from Table No. 19; pages 314, 325).

Percentile Grades.

Height Sitting.

Boys: Unbroken Lines. Girls: Broken Lines.



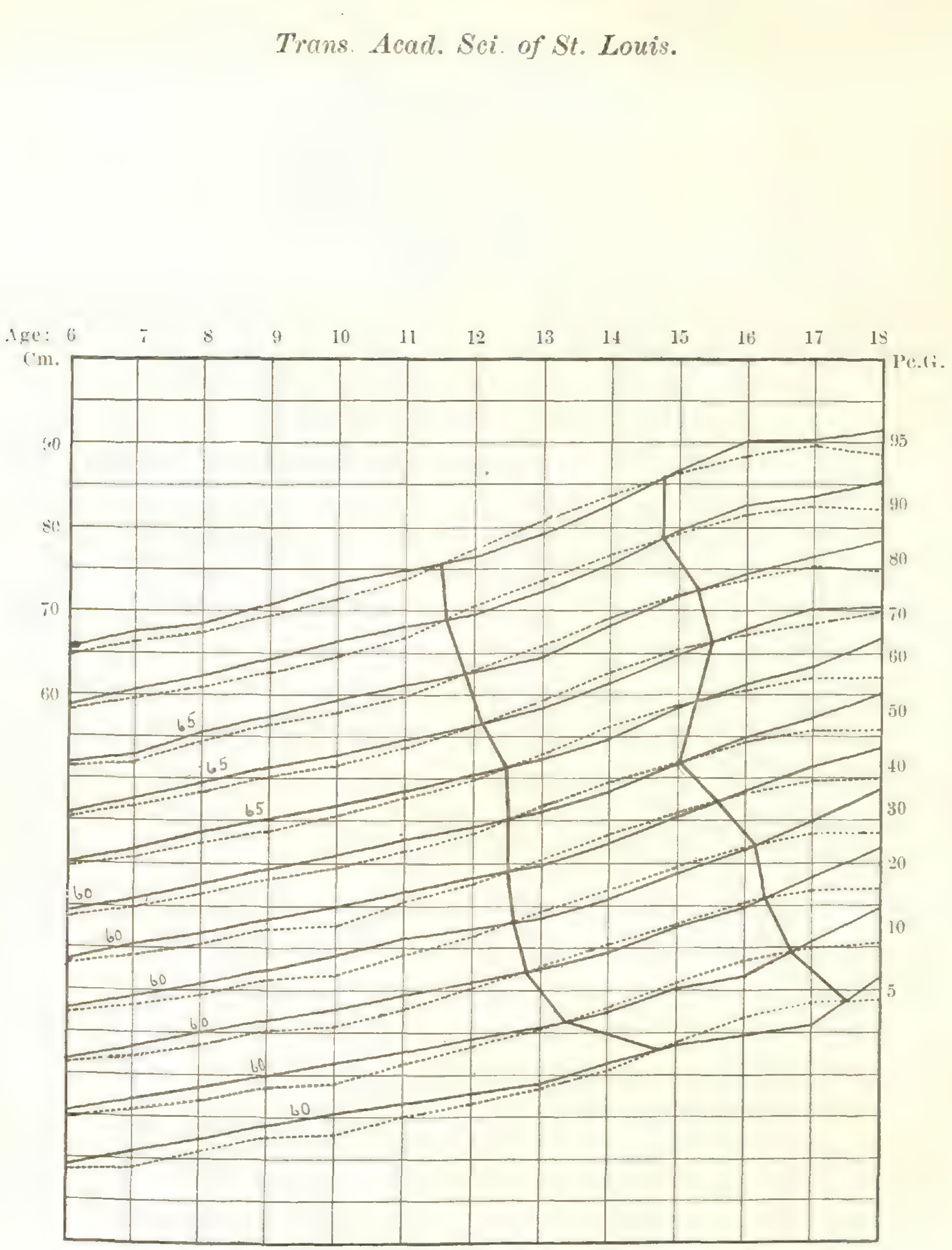
VOL. VI. NO. 12. PLATE XL (from Table No. 20; pages 315, 325).

Percentile Grades.

Span of Arms.

Boys: Unbroken Lines.

Girls: Broken Lines.

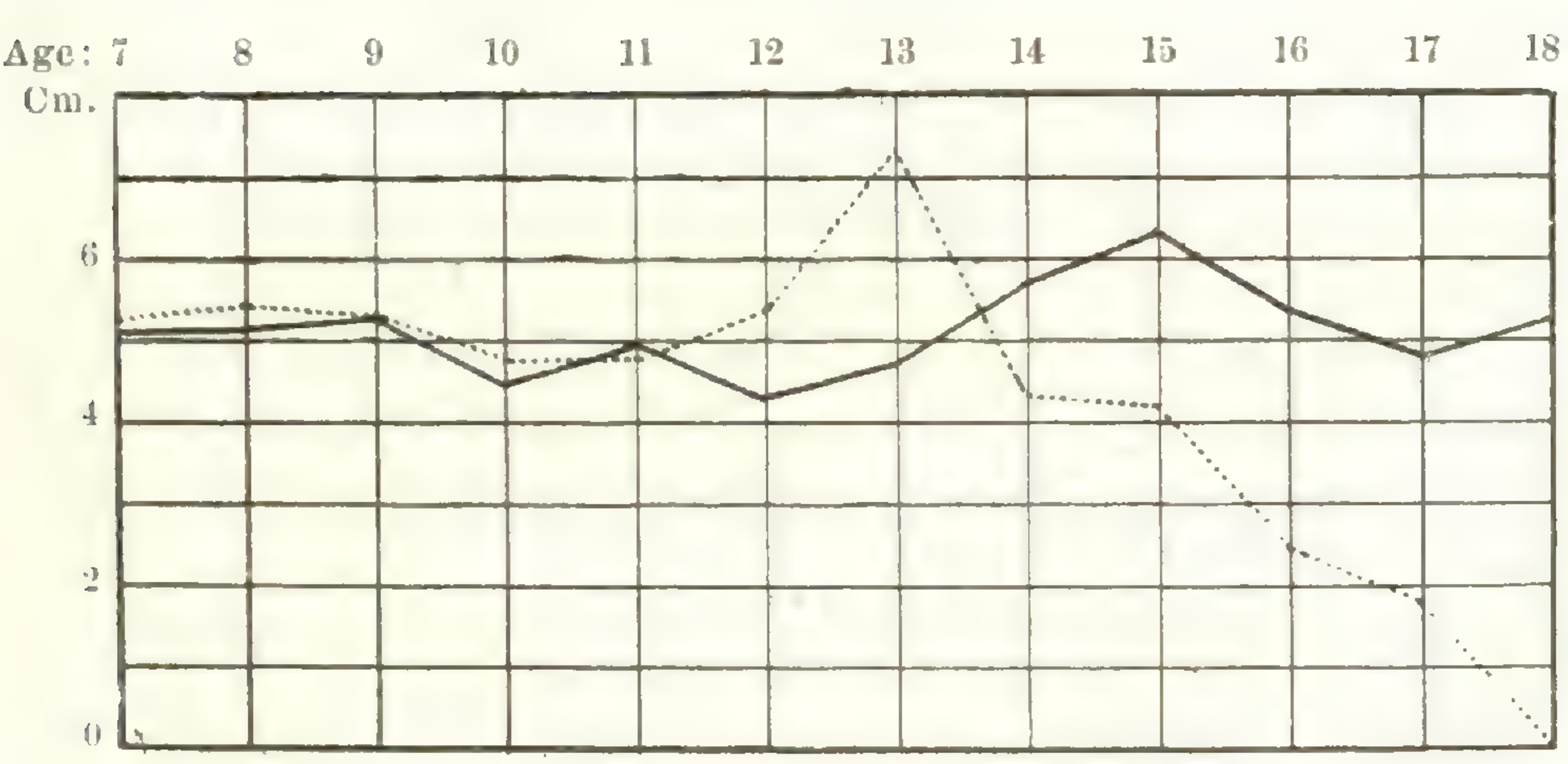


VOL. VI. NO. 12. PLATE XLI (from Table No. 23; pages 318, 325).

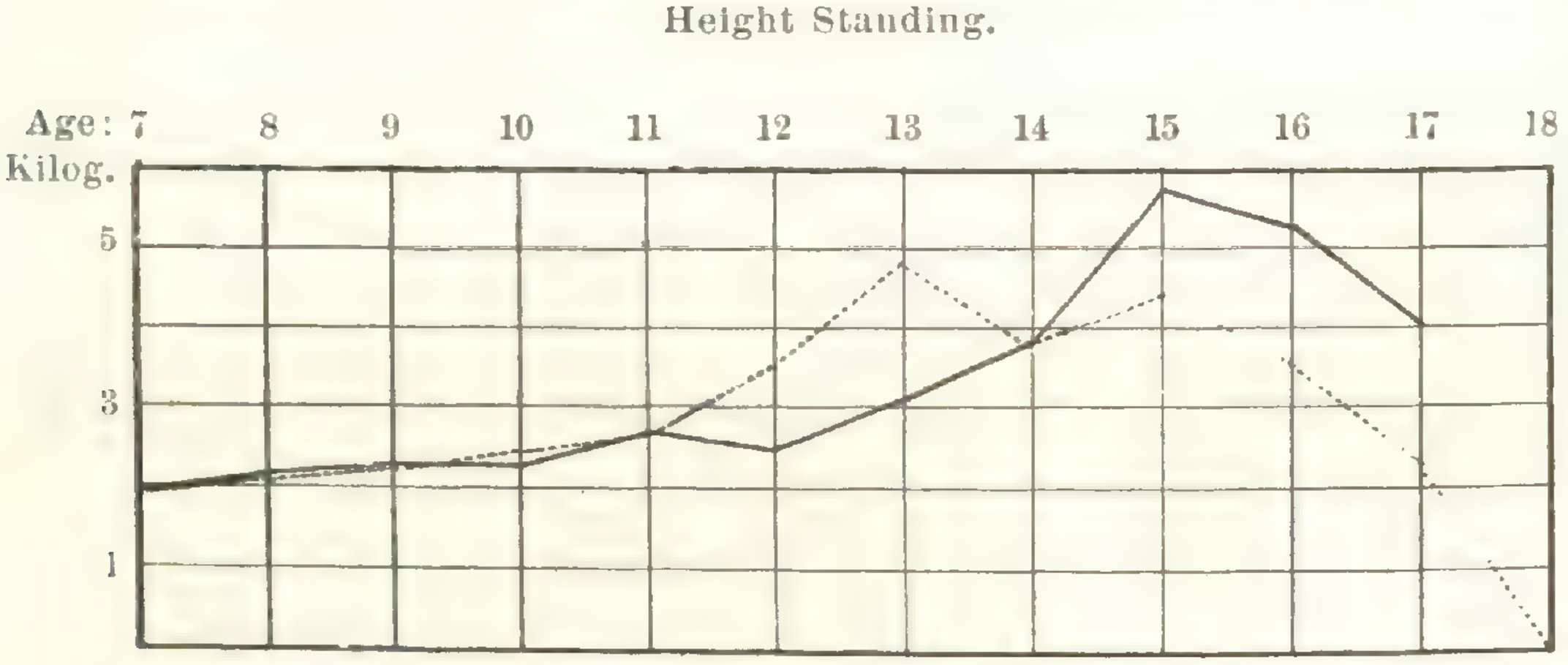
Percentile Grades.

Girth of Chest.

Boys: Unbroken Lines. Girls: Broken Lines.



Height Standing.



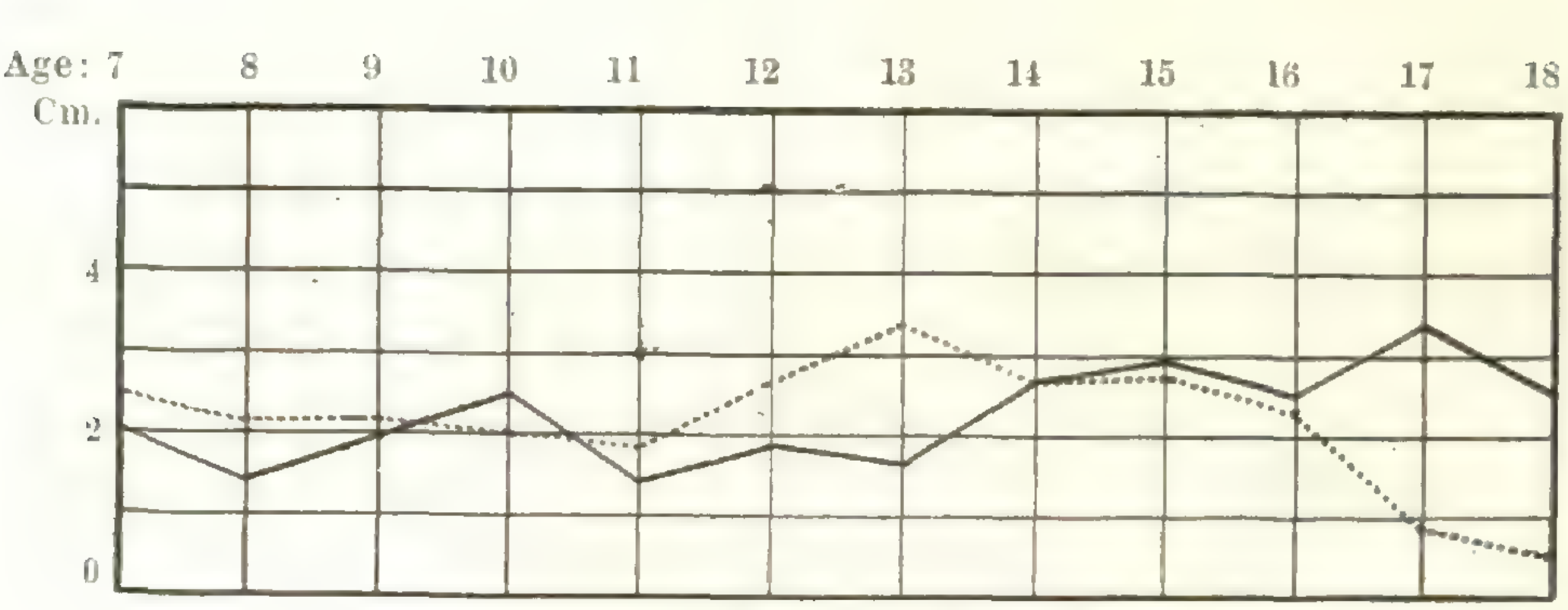
Weight.

Span of Arms.

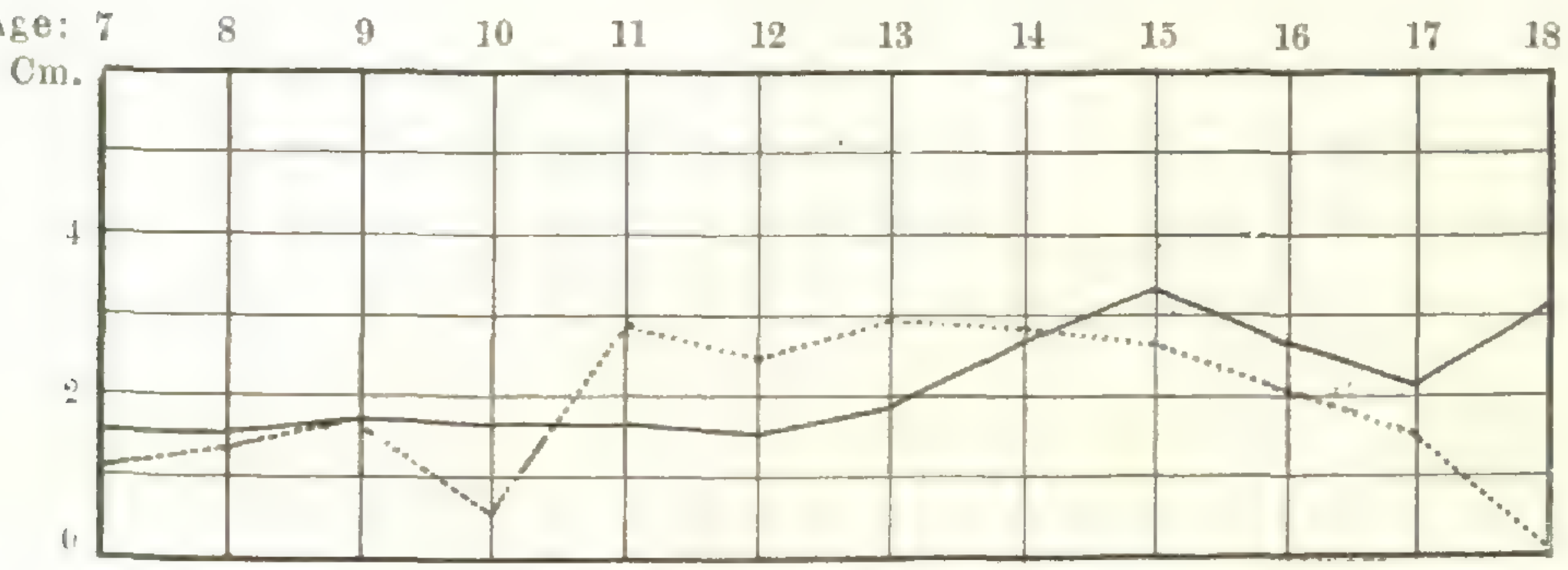
VOL. VI. NO. 12. PLATE XLII (from Tables No. 30, 31, 32; pages 327, 328, 329, 330.

Absolute Annual Increase.

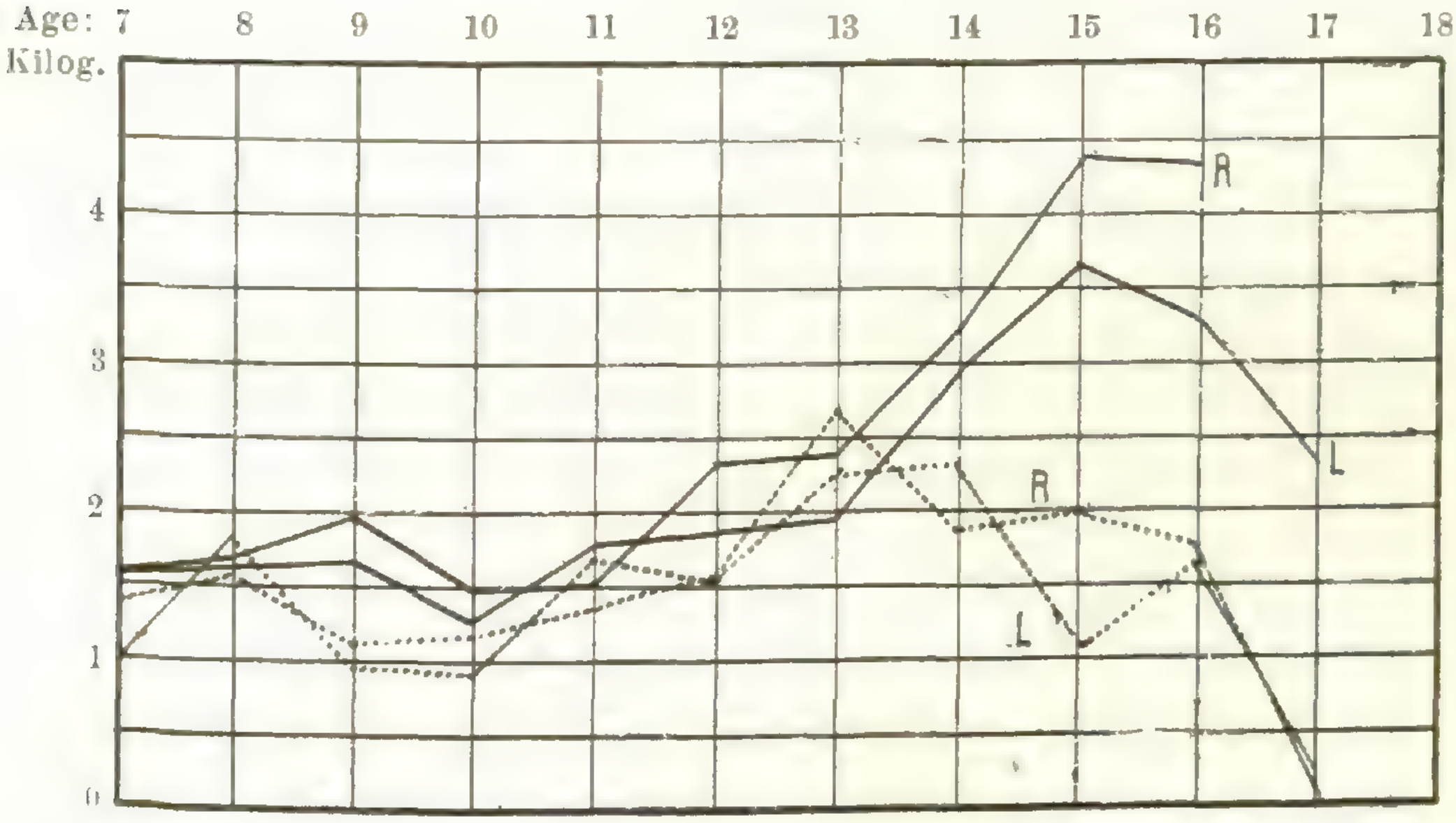
Boys: Unbroken Lines. Girls: Broken Lines.



Height Sitting.



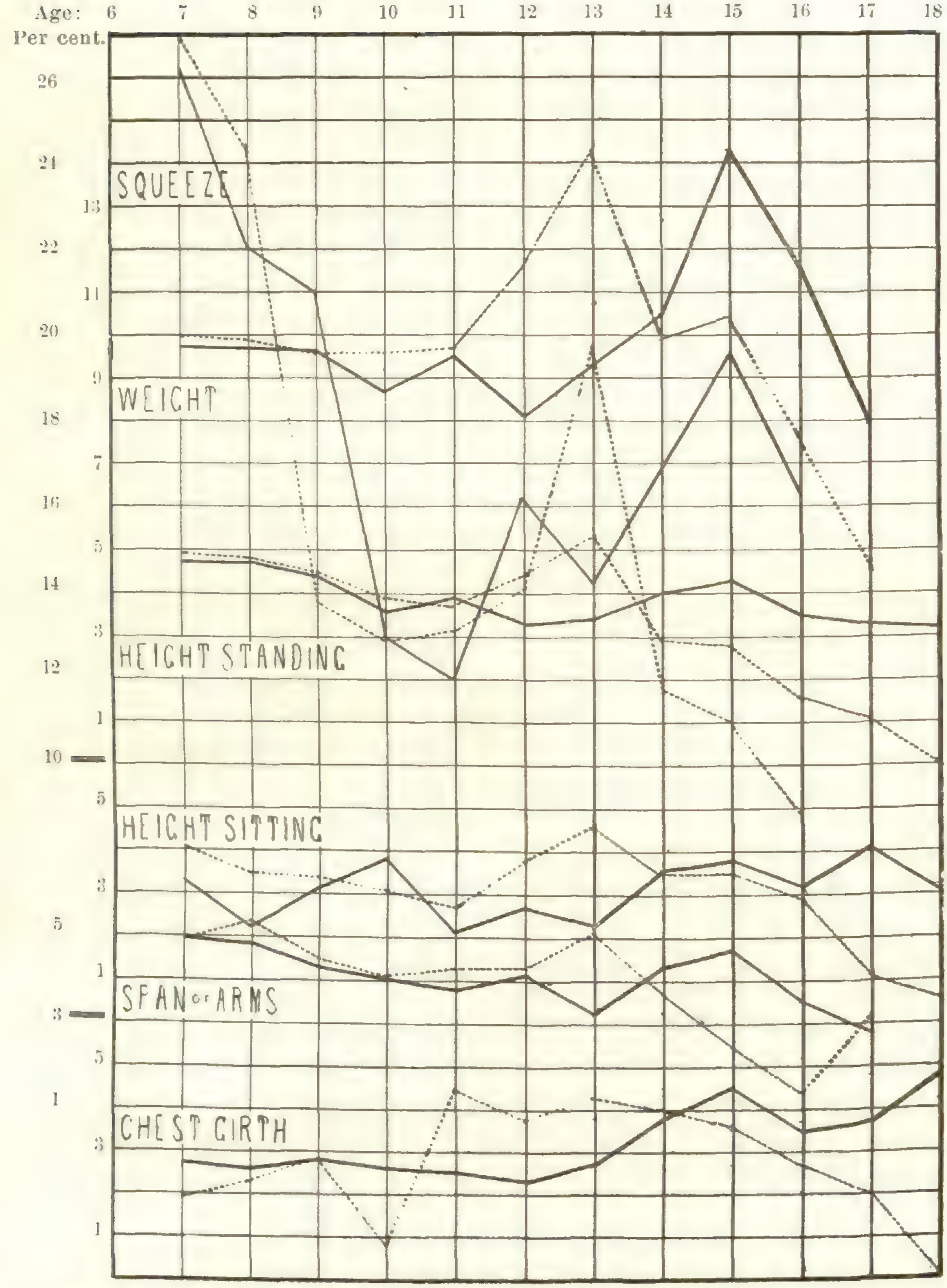
Girth of Chest.



Strength of Squeeze.

Absolute Annual Increase.

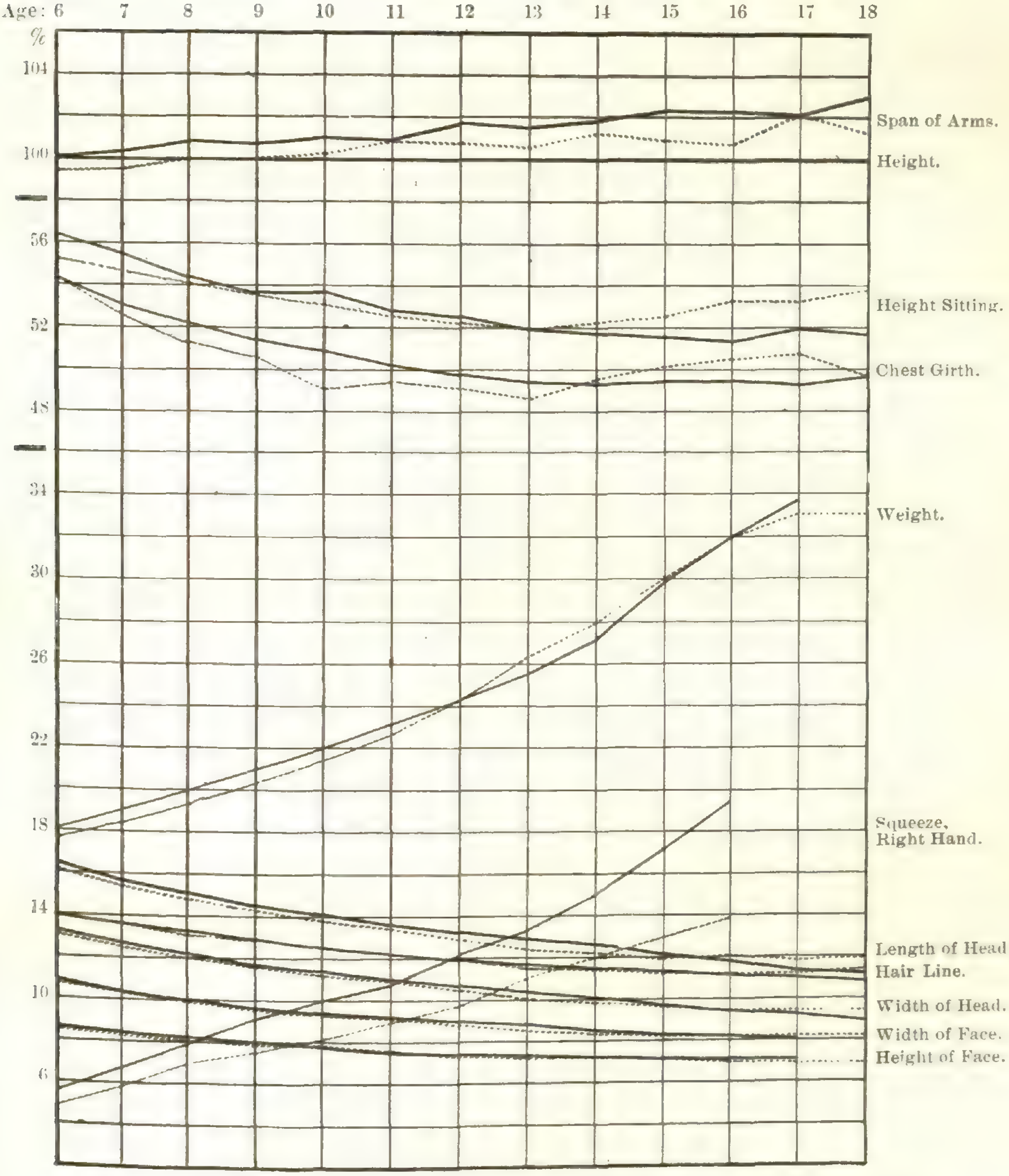
Boys: Unbroken Lines. **Girls: Broken Lines.**



VOL. VI. NO. 12. PLATE XLIV (from Tables No. 38 to 43; pages 327, 333, 350 to 355).

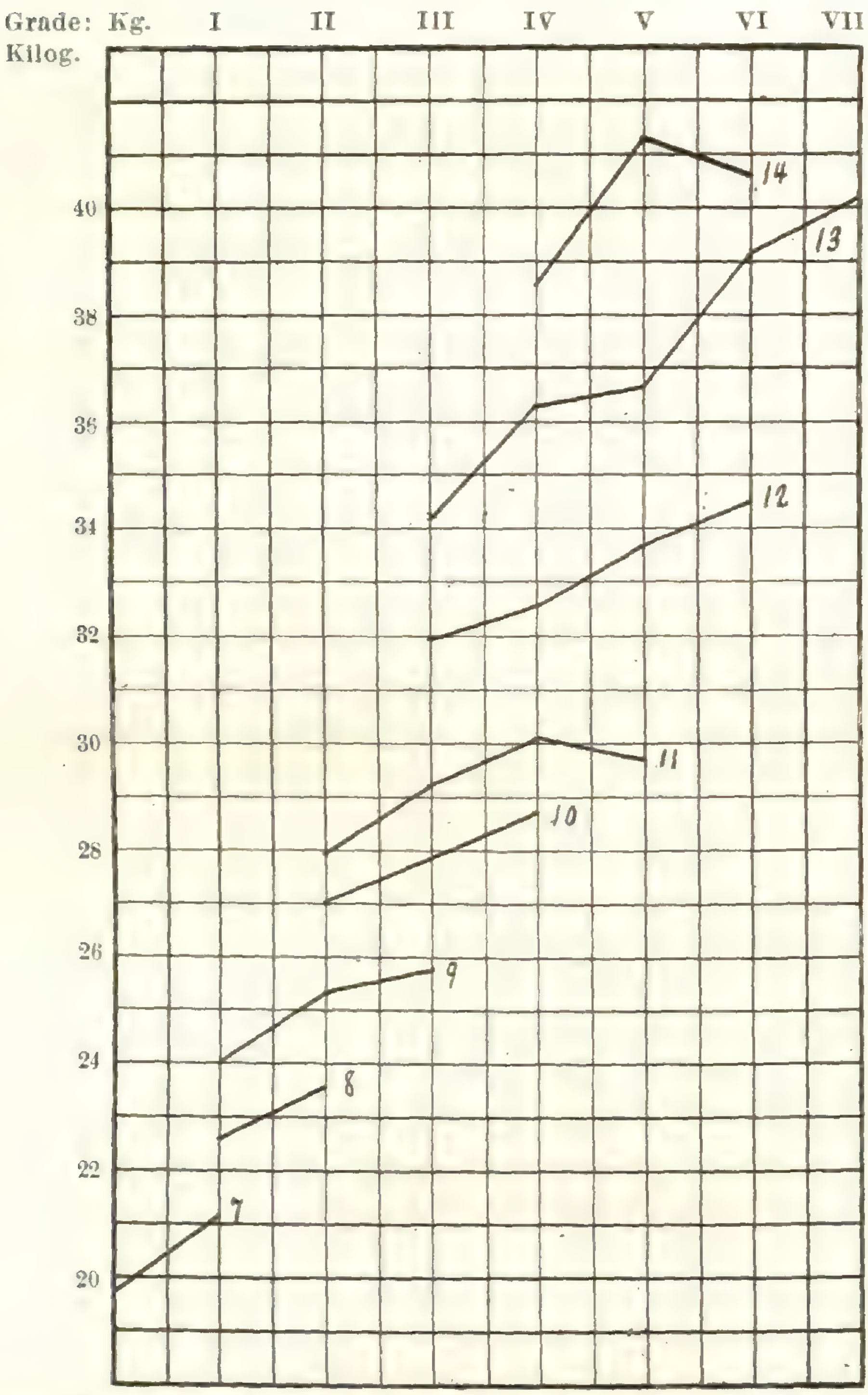
Relative Annual Increase.

Boys: Unbroken Lines. **Girls: Broken Lines.**



VOL. VI. NO. 12. PLATE XLV (from Table No. 38 to No. 51; pages 334, 350 to 363).

Relation of Average Weight, Span of Arms, Girth of Chest, etc., to Average Height.



VOL. VI. NO. 12. PLATE XLVI (from Table No. 36; pages 336, 337).

The Weights of Daughters of Manual Tradesmen distributed by School Grade.

Transactions of The Academy of Science of St. Louis.

VOL. VI. No. 13.

A STUDY OF THE RELATIONS OF SALIX NIGRA AND SALIX AMYGDALOIDES, TOGETHER WITH THE HYBRIDS ARISING FROM THEM AS THESE SPECIES EXHIBIT THEMSELVES IN THE VICINITY OF ST. LOUIS.

N. M. GLATFELTER, M. D.

Issued April 17, 1894.

A STUDY OF THE RELATIONS OF SALIX NIGRA AND SALIX AMYGDALOIDES, TOGETHER WITH THE HYBRIDS ARISING FROM THEM AS THESE SPECIES EXHIBIT THEMSELVES IN THE VICINITY OF ST. LOUIS.

N. M. Glatfelter, M. D.

From considerable previous observation having noticed the difficulty of classifying many of the specimens either with the one or the other of the two species named in the subject of this paper, I resolved in the early part of the season just passed to collect a large number of specimens with the view of ascertaining the essential characters of each and thus, perhaps, fixing their proper limits. The result of my efforts is 182 pressed specimens from as many different plants, taken at random as I came across them. These are all numbered and tabulated with reference to their various characters.

I am well aware that any inferences drawn from them have only a local significance, but yet deem them not without value, nor without some degree of general interest. The large number of hybrids in the collection (38 %), has been quite a surprise to myself. I found the hybridization to be of every possible degree of intermixture or complexity, graduating by shades from one species to the other. Often at first sight, the specimen in hand appears to belong to the one or the other, when upon closer inspection one will find defection of or addition of one or more important characters properly pertaining to the pure form. It is to be understood as a matter of course that a certain degree of latitude has to be permitted for the usual amount of variation of a species. Owing to the strong contrast presented by the parents in several important characters there is ordinarily no difficulty

in determining the hybrids. The distinction between the parents may be readily seen from the following comparison: —

S. amygdaloides.	*S. nigra.*
Tree stem usually single, limbs straight.	Stems mostly clustered, more crooked limbs.
*Bark smooth or only rough, bases of branchlets brittle.	*Bark flaky or shaggy, bases of branchlets very brittle.
The terminal ends of branchlets frequently winter-killed.	The same not winter killed.
Leaves not usually affected with blister-like mite-galls.	Leaves frequently affected with such galls.
*Under surface of leaves glaucous or pale, bluish-green.	*Green throughout.
Bases of leaves *acute*, round, or sub-cordate.	A tendency to obtuseness or even truncateness.
Leaves ovate-lanceolate.	Leaves oblong or linear lanceolate.
Veining coarser, stronger, whiter; secondaries more regular and pronounced.	Veining very minute, with frequently a marginal line.
Young shoots of sterile plant, mostly fragrant in early season.	Young shoots never fragrant.
*Petioles long.	*Petioles short.
Stipular in 76 %, deciduous.	Stipular, 57 %, rather persistent.
*Stipules all obtuse or rounded.	*Stipules pointed, all but *one*.
*Stipules glandular.	*Stipules not glandular.
Petiole at base of leaf often glandular.	The same never glandular.
*Young shoots and leaves smooth.	Young shoots and mid-rib mostly pubescent, 87 %.
Date of blossoming mostly from April 15th to 25th.	The same after May 3d.
Stamens mostly more than six.	Stamens mostly less than six.
Scales of sterile aments ovate or oblong, acute.	Scales shorter, obtuse, more villous.
*Fertile aments loose.	*The same compact.
*Pedicels long.	*Pedicels short.

It is seen that the differences are many, and some of them very marked. Those marked with an asterisk indicate the

more prominent and persistent differences, though yet other characters may be quite as important, for example, the period of blossoming, or the difference in veining. When stipules are present I venture to assert if they are pointed, or if not glandular, the specimen under investigation cannot be S. Amygdaloides; and, on the other hand, if glandular, it can not be pure S. nigra. The several types of leaves, stipules and fruits of each of the two species are illustrated on the accompanying plate.

The following summary taken from my record will show at a glance the differences between nigra and amygdaloides: —

	Whole No. Collected.	Stipules Large.	Stipules Small.	Stipules None.	Stipules Glandular	Stipules Glandular Not Recorded.	Stamens More than 6.	Stamens 6 and under.	Pubescence.	Pubescence Moderate.	Smooth.	Scales Ovate — Acute.	Scales Obtuse.
Amygd. fertile	15	5	4	6	9	....	....	....	....	....	15	....	....
" sterile	11	8	2	1	8	2	6	2‖	..	...	11	9	4
" no fruit or flower	40	15	16	9	31	....	....	....	....	....	40	....	....
Total	66	28	22	16	48	2	6	2	....	....	66	9	4
Nigra fertile	17	6	4	7	4¶	...	....	....	14	....	3	....	....
" sterile	14	2	4	3	1(?)	5	3	11	14	....	....	7	11
" no fruit or flower	16	5	6	5	. ..	....	....	....	11	2	3	....	....
Total	47	13	14	15	5¶	5	3	11	39	2	6	7	11

‖ 3 Not Recorded. ¶ Slight.

The following table embracing specimens of mixed forms selected from my list may prove interesting as showing the variations in hybidrization, as well as my method of recording. In the columns headed amygdaloid and nigra, an attempt was made to classify the specimens with that species to which they appear to come the nearest. While my data show that of pure amygdaloides 73 per cent blossomed from April 15th to 25th, and of pure nigra, all of the 14 sterile specimens after May 3d, the 9 specimens of mixed sterile were collected between

April 23d and May 7th, thus proving that their time of flowering also is intermediate.

Mixed Forms.	Single specimens selected. List No.	Date of Collection.	Stip. pointed.	Stip. unpointed.	Petiole.	Pedicel.	Pubescence.	Stip. glandular.	Leaf green.	Sub-glaucous.	Base acute.	Base obtuse.	Stamens.	Bark.	Nearest Amygdaloid.	Nearest Nigra.	Remarks.
Sterile.	3	5–2															
		6–9															
		9–18	x!	....	s.	....	....	x	x!	.. .	....	x	5–6	Sm.	x	....	Fr.
	5	5–17															
		5–28															
		9–17	....	x	l.	....	....	v	x!	....	x	....	6-8	r.	....	x	
	9	4–26															
		6–18	....	x	m.	...	....	x	....	v	x	x	6–9	Sc.	x	....	
Fertile.	5	6–17	....	x	m.	m.	x	....	x	....	....	x	....	r.	....	x	
	8	5–26															
		7–25															
		9–18	x!	....	m.	s.	...	v	x!	...	x	x	....	Sm.	x	x	
	12	6–17	x!	....	l.	l.	....	v	x!	....	....	x	....	r.	x	....	Sub-fr
Without fruit or flower.	12	6–25	x	....	s.	....	....	v	x	....	....	x	....	No record	x	....	
	35	6–9	x	..	m.	....	....	v	x!	....	....	x	....		x	....	
	44	6–15	x	....	l.	....	x	v	x!	....	x	....	....		....	x	

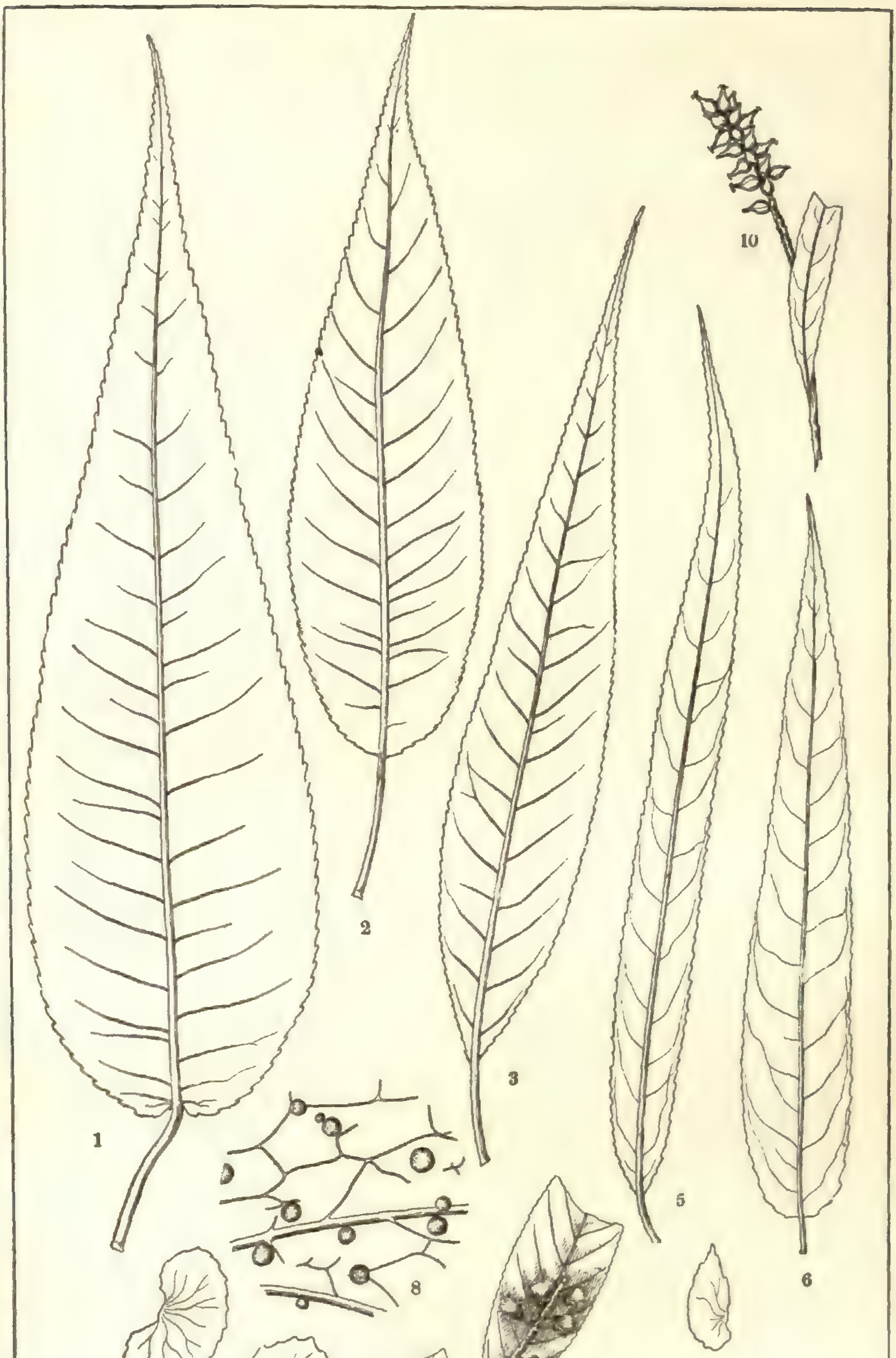
s, short; l, long; m, medium; Sm, smooth; r, rough; Sc, scaly; !, exaggerates; v, moderate; fr, fragrant.

The question arises, may there not be contamination from other species of Willows? I found no evidences of this, and am strongly of the opinion there is not. The only other native species growing in this vicinity are S. cordata and S. longifolia; and, very sparingly, S. humilis, and S. sericea, to none of which are nigra or amygdaloid closely allied. S. lucida from which the glandular character of amygdaloid might be thought to be derived does not grow here, and is extremely rare even as an ornamental tree. Contrary to descriptions in standard works S. amygdaloides is more frequently stipular and has larger stipules than S. nigra. The stipules being present mostly with vigorous shoots, holds true largely also in respect to S. nigra.

While the differences between the two under consideration are so striking there yet appears a remarkable closeness in their nature permitting them to hybridize so freely with each other. The plan of their venation is similar. I would be inclined to think that even those specimens of Amygdaloid

which I have classed as pure, might be contaminated with nigra, but for the fact that those most stipular are also most glaucous, most glandular, and most frequently fragrant, characters entirely absent from nigra. The leaf-shape of the mixed forms follows the various forms of parents, often a compromise between the two. The veining appears most strongly affected by nigra.

Issued April 17, 1894.



VOL. VI. NO. 13. PLATE I. GLATFELTER.

Explanation of Plate — 1-3, leaf forms; 4, stipules; 8, stipule glands; 9, fruit of *Salix amygdaloides;* 5–6, leaf forms; 7, stipules; 10, fruit of *S. nigra*. All natural size except figure 8, which is enlarged 18 diameters.

Transactions of The Academy of Science of St. Louis.

VOL. VI. No. 14.

FLOWERS AND INSECTS — ROSACEAE AND COMPOSITAE.

CHARLES ROBERTSON.

Issued April 26, 1894.

FLOWERS AND INSECTS — ROSACEAE AND COMPOSITAE.

CHARLES ROBERTSON.

Contributions to an account of the mutual biological relations of the entomophilous flora and the anthophilous insect fauna of Macoupin County, Illinois.

PRUNUS AMERICANA L. — The trees grow a few metres high and are covered in early spring with a profusion of white flowers, which appear with the leaves. The corolla expands from 15 to 20 mm. When the corolla opens, the style with its stigma already receptive is exposed to insects, while the anthers are still closed. This gives abundant opportunity for cross-pollination between flowers of the same or of different trees. After the anthers begin to dehisce, cross-pollination is still readily effected by insects touching the stigma first. But insects coming without pollen may effect self-pollination. In case insect-visits fail, spontaneous self-pollination may occur in those flowers in which some of the stamens equal or exceed the style in length, by the flowers closing up so that the anthers may be thrown against the stigma, or turning horizontally, so that some of the pollen may fall upon the stigma. In many flowers, however, the stigma so far surpasses the anthers that spontaneous self-pollination is impossible. Nectar is secreted by the broad wall of the receptacular tube. The tube is somewhat contracted at the mouth and slightly obstructed by the bases of the filaments.

The flowers are in bloom from April 15 to May 5. They are visited mainly by bees and flies. The following visitors were noted on April 17, 26 and 27: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., ab.; *Andrenidae*: (2) Andrena sayi Rob. ♂ ♀, s. and c. p., freq.; (3) A. salicis Rob. ♂, s.;

(4) A. cressonii Rob. ♂, s.; (5) A. flavoclypeata Sm. ♂, s., freq.; (6) Halictus lerouxii Lep. ♀, s.; (7) H. zephyrus Sm. ♀, s.; (8) H. confusus Sm. ♀, s. and c. p.; (9) H. stultus Cr. ♀, s.; (10) Colletes inaequalis Say ♀, s.

Diptera — *Bombylidae:* (11) Bombylius major L. s.; *Syrphidae:* (12) Chrysogaster nitida Wd.; (13) C. ustulata Lw.; (14) Platychirus hyperboreus Staeg.; (15) Syrphus americanus Wd.; (16) S. ribesii L.; (17) Mesograpta geminata Say; (18) Sphaerophoria cylindrica Say; (19) Eristalis dimidiatus Wd.; (20) Helophilus similis Mcq.; (21) Brachypalpus frontosus Lw.— all f. p. and sometimes s.; *Tachinidae:* (22) Gonia frontosa Say, s.; *Sarcophagidae:* (23) Cynomyia sp., s.; *Muscidae:* (24) Lucilia caesar L., s.; (25) L. cornicina F., s.; *Cordyluridae:* (26) Scatophaga squalida Mg., f. p.

Lepidoptera — *Nymphalidae:* (27) Pyrameis atalanta L.; (28) P. huntera F.; *Noctuidae:* (29) Plusia simplex Gn.; (30) sp. — all sucking.

Coleoptera — *Chrysomelidae:* (31) Orsodachna atra Ahr., f. p.

PRUNUS SEROTINA Ehrh. — The trees are filled with small racemes which bear numerous small white flowers. The flowers measure about eight millimetres across. When they open, the stigma, which is already receptive, exposes its broad surface above the anthers, which are still closed and are held down by the incurved stamens. Later the stamens turn outwards and discharge their pollen. Flowers which are imperfectly expanded show the anthers discharging their pollen so near to the stigma that self-pollination is insured. The receptacular tube forms a shallow cup, the inner wall of which secretes nectar. The nectar is readily accessible to short-lipped insects, the style and stamens forming a very trivial obstruction in the way of the guests.

This species blooms later than *P. americana*, April 25 – May 23, and has more exposed nectar. Its visitors are like those of *Crataegus*. May 7, 13, and 18, I noted as visitors :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus americanorum F. ♀, s., freq.; (3) B. virginicus Oliv. ♀, s.; (4) B. separatus Cr. ♀, s.; (5) Synhalonia speciosa Cr. ♂, s.; (6) Ceratina tejonensis Cr. ♂, s.; (7) Nomada sayi Rob. ♀, s.; *Andrenidae:* (8) Andrena pruni Rob. ♀, s.and c. p., freq.; (9) A. sayi Rob. ♀, s. and c. p.; (10) A. cressonii Rob. ♂ ♀, s. and c. p., freq.; (11) A. flavo-clypeata Sm. ♀, s. and c. p., ab.; (12) A. nuda, Rob. ♀, s. and c. p.; (13) A. rugosa Rob. ♂, s.; (14) A. forbesii Rob. ♀, s. and c. p.; (15) A. claytoniae Rob. ♀, s. and c. p., freq.; (16) A. crataegi Rob. ♂, s.; (17) Halictus coriaceus Sm. ♀, s., freq.; (18) H. lerouxii Lep. ♀, s. and c. p., freq.; (19) H. fasciatus Nyl. ♀, s. and c. p.; (20) H. pilosus Sm. ♀, s. and c. p.; (21) H. cressonii Rob. ♀, s. and c. p.; (22) H. zephyrus Sm. ♀, s. and c. p.; (23) H. confusus Sm. ♀, s. and c. p., freq.; (24) H. stultus Cr. ♀, s. and c. p., freq.; (25) Agapostemon radiatus Say ♀, s.; (26) Augochlora lucidula Sm. ♀, s.; (27) A. similis

Rob. ♀, s. and c. p., freq.; *Vespidae:* (28) Polistes metricus Say, s. *Tenthredinidae:* (29) Dolerus sericeus Say, s.

Diptera — *Stratiomyidae:* (30) Stratiomyia quaternaria Lw., s.; *Empidae:* (31) Rhamphomyia sp., s.; *Conopidae:* (32) Myopa vesiculosa Say, s.; *Syrphidae:* (33) Pipiza pistica Will., s.; (34) Chrysogaster nitida Wd., s.; (35) Syrphus ribesii L., f. p.; (36) Sphaerophoria cylindrica Say, s.; (37) Myiolepta strigillata Lw., s.; (38) Eristalis aeneus F., s., freq.; (39) E. dimidiatus Wd., s.; (40) Syritta pipiens L., s.; *Tachinidae:* (41) Gonia frontosa Say, s.; *Sarcophagidae:* (42) Cynomyia sp., s.; (43) Sarcophaga sp., s.; *Muscidae:* (44) Calliphora erythrocephala Mg., s.; (45) Lucilia sp., s.; (46) L. caesar L., s.; (47) L. cornicina F., s.; (48) L. latifrons Schin., s.; *Anthomyidae:* (49) Chortophila sp., s.; *Cordyluridae:* (50) Scatophaga squalida Mg., s.

Lepidoptera — *Nymphalidae:* (51) Danais archippus F., s.; (52) Pyrameis huntera F., s.

Coleoptera — *Cerambycidae:* (53) Molorchus bimaculatus Say, s.

Spiraea aruncus L.—The flowers of this plant are said by Müller * to be devoid of honey, but I have seen insects sucking. If the flowers were destitute of nectar, the plants which bear only pistillate flowers, which of course supply no pollen, would not be visited by insects. This comes nearer to being a beetle-flower than any flower I have observed. Of the twenty-four species of insects taken on the flowers, fifteen are beetles. As far as observed the flowers bloom from June 6 to 16. June 7th and 10th, the following visitors were taken:—

Coleoptera — *Dermestidae:* (1) Anthrenus musaeorum L., ab.; (2) Cryptorhopalum haemorrhoidale Lec.; (3) C. triste Lec., ab.; (4) Orphilus glabratus F., freq.; *Cerambycidae:* (5) sp.; (6) Euderces picipes F., ab.; (7) Acmaeops directa Newm.; *Chrysomelidae:* (8) sp.; *Bruchidae:* (9) Bruchus hibisci Oliv.; *Mordellidae:* (10) Mordella marginata Melsh., ab.; (11-12) Mordellistena spp.; (13) M. biplagiata Heb.; *Curculionidae:* (14) Centrinus picumnus Hbst., ab.; (15) Coleop. sp.— all f. p. or s.

Hymenoptera — *Andrenidae:* (16) Andrena sp. ♀, s.; (17) A. rugosa Rob. ♀, s.; (18) A. crataegi Rob. ♀, c. p.; (19) A. cressonii Rob. ♀, s.; (20) Halictus stultus Cr. ♀, s.; (21) Prosopis affinis Sm. ♂ ♀, s. and f. p., freq.

Diptera—*Empidae:* (22) Empis distans Lw., s.; *Oscinidae:* (23–24) spp., s.

In his garden at Lippstadt Müller found the flowers to be visited by four beetles and five other insects.†

Rubus occidentalis L.— The flowers grow in quite inconspicuous clusters, and open in succession. They expand as

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* Fertilization of Flowers, 224.

† See Table III.

wide as fifteen millimetres, but on account of the short and narrow petals they are far from showy.

The stigmas become receptive before the anthers dehisce. The stamens are numerous, but short, and the outer ones discharge their pollen first. There is an opportunity for cross-pollination, for self-pollination by insects, and for spontaneous self-pollination in absence of insects. But the inner and upper stigmas can hardly receive pollen except by insect aid.

The honey secreting ring between the outer pistils and inner stamens is more readily accessible than in *R. villosus*, on account of the stamens being shorter and less abundant.

I have seen the flowers visited by *Andrena bicolor* F. ♀, and *Odynerus anormis* Say.

Rubus villosus Ait. — The stems rise from one to two metres high and bear numerous white flowers, which expand horizontally from two to four centimetres.

When the flowers first open, the numerous stigmas are receptive while the anthers are still closed. At this time, and later, when the outer anthers are discharging their pollen, a bee entering the flower may readily effect cross-pollination. At the same time, insects coming without pollen may effect self-pollination. When the inner anthers dehisce, spontaneous self-pollination may occur, for the stamens far overtop the stigmas.

Nectar is secreted by a narrow ring between the base of the receptacle and the filaments. The nectar is entirely concealed and rendered quite deep-seated by the dense circle of numerous stamens.

On account of their large size and rather deeply-seated, concealed nectar, the flowers seem to be specially adapted to bumble-bees, which are in fact the principal and most efficient visitors, but smaller insects occur and may effect pollination, though by no means so readily.

The flowers were noted in bloom from May 11 to June 22, The following visitors were taken May 24 and 29: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s., freq.; (2) Bombus americanorum F. ♀, s., freq.; (3) B. pennsylvanicus DeG. ♀, s.; (4) Ceratina dupla Say ♀, s.; *Andrenidae:* (5) Andrena sayi Rob. ♀, c. p.; (6) A.

crataegi Rob. ♀, c. p.; (7) Halictus pectoralis Sm. ♀, c. p.; (8) H. fasciatus Nyl. ♀, c. p.; (9) H. stultus Cr. ♀, c. p.

Diptera — *Empidae:* (10) Empis distans Lw., s.; *Syrphidae:* (11) Syritta pipiens L., f. p.

GEUM ALBUM Gmelin. — The stems grow about six decimetres high and bear scattered flowers, which have white petals and expand 18 or 20 millimetres.

The flowers are proterogynous. The outer anthers dehisce first. There is abundant opportunity for cross-pollination. Later, self-pollination by insect aid is possible. In case insects fail, the lower stigmas may receive pollen from the neighboring anthers.

Nectar is secreted by the portion of the disc on which the stamens are inserted.

The flowers are visited by small Hymenoptera and Diptera. I have noted them in bloom from June 20 to September 13. The insects mentioned in the following list were noted on the flowers on July 6 and 11: —

Hymenoptera — *Apidae:* (1) Phileremus illinoensis Rob. ♀, s.; (2) Calliopsis andreniformis Sm. ♂, s.; *Andrenidae:* (3) Halictus fasciatus Nyl. ♂, s.; (4) H. pilosus Sm. ♀, s.; (5) H. pruinosus Rob. ♀, s. and c. p.; (6) H. confusus Sm. ♀, s. and c. p.; (7) H. tegularis Rob. ♀, s.; (8) H. stultus Cr. ♀, s. and c. p.; (9) Augochlora similis Rob. ♂♀, s. and c. p.; (10) Prosopis pygmaea Cr. ♂, s.; *Eumenidae:* (11) Eumenes fraternus Say, s.; (12 and 13) Odynerus spp., s.; *Crabronidae:* (14) Crabro interruptus Lep., s.; *Philanthidae:* (15) Cerceris compacta Cr., s.; *Chrysididae:* (16) Hedychrum violaceum Brullé, s.

Diptera — *Syrphidae:* (17) Mesograpta marginata Say, s.; *Tachinidae:* (18) Ocyptera sp., s.; *Sarcophagidae:* (19) Sarcophaga sp., s.

Coleoptera — *Cerambycidae:* (20) Euderces picipes F., s.; *Mordellidae:* (21) Mordella marginata Melsh., s.

Hemiptera — *Corimelaenidae:* (22) Corimelaena pulicaria Germ., s.

GEUM VERNUM Torr. & Gr. — A few stems from the same base rise three or four decimetres in height and bear small cymes of yellow flowers.

The flowers expand about six or seven millimetres, the petals, however, being quite small and inconspicuous. The concavity of the receptacular tube is filled by a globular head of pistils. Above, it is produced into a thin, many-lobed rim which separates the head of pistils from the stamens. The filaments are inserted in a groove lying between this rim and

the insertion of the petals and sepals. An outer circle of stamens has straight filaments and erect anthers. The anthers of this circle dehisce before the others. The stamens of the inner circle have their filaments inflected, the indehiscent anthers being held between the head of pistils and the raised edge of the receptacle.

Nectar is secreted and lodged in the groove near the bases of the filaments. The flowers are homogamous. Insects visiting the flowers may effect cross-pollination. The anthers of the outer circle do not readily come in contact with the stigmas. When those of the inner circle dehisce, they often touch the stigmas of the lower pistils, but most of the pistils can receive pollen only through the agency of insects.

I have seen the flowers visited for nectar and pollen by *Augochlora pura* Say ♀.

FRAGARIA VIRGINIANA Mill., *var.* ILLINOENSIS Gr. — The plants are commonly collected in small patches. The scapes rise from one to two decimetres high and bear a few white flowers which expand horizontally from 15 to 25 millimetres. The flowers are gynodioecious, the female flowers being smaller and bearing aborted stamens. The hermaphrodite flowers are proterogynous, and there is, accordingly, abundant opportunity for cross-pollination of these flowers. The anthers stand so directly over the stigmas that, when the pollen is discharged, self-pollination may be effected by insects or by the pollen falling upon the stigmas. Nectar is secreted by a narrow portion of the receptacle and is held between the bases of the filaments and the outer pistils. It is, therefore, only imperfectly concealed and can be obtained by small bees and flies. The principal visitors are bees of the genus *Halictus*. The list contains visitors observed May 15th:—

Hymenoptera — *Apidae:* (1) Synhalonia speciosa Cr. ♂, s.; (2) Ceratina dupla Say ♂, s.; (3) Nomada superba Cr. ♂, s.; *Andrenidae:* (4) Halictus ligatus Say ♀, s.; (5) H. fasciatus Nyl. ♀, s., freq.; (6) H. pilosus Sm. ♀, s.; (7) H. confusus Sm. ♀, s. and c. p., freq.; (8) H. tegularis Rob. ♀, s.; (9) Augochlora pura Say ♀, s.; (10) A. similis Rob. ♀, s. and c. p., ab.; (11) Prosopis affinis Sm. ♂, s.; (12) P. pygmaea Cr. ♀, s.

Diptera — *Syrphidae:* (13) Paragus bicolor F., s. and f. p., freq.; (14) Sphaerophoria cylindrica Say, s. and f. p.; (15) Tropidia mamillata Lw.;

Sarcophagidae: (16) Sarcophaga sp., s., freq.; *Muscidae:* (17) Lucilia sylvarum Mg., s.

POTENTILLA CANADENSIS L.— Except in their yellow color and smaller size, the flowers bear a strong resemblance to those of *Fragaria.* The plants are common and are often collected in patches of considerable size. A few stems rise from the same base and are ascending or trailing. A single plant does not bear many open flowers at a time, since the flowers are single on axillary peduncles, and there is therefore an increased opportunity for cross-pollination between distinct plants.

The flowers expand horizontally about fifteen millimetres. Nectar is secreted on the narrow line between the outer pistils and the stamens. The pistils have their stigmas receptive before the anthers dehisce. In case cross-pollination does not take place oefore the pollen is discharged, self-pollination may occur by insect aid, or spontaneously by the pollen falling upon the stigmas.

The blooming time is from April 30 to June 17. The visitors mentioned below were taken on May 18 and June 2:—

Hymenoptera—*Apidae:* (1) Bombus americanorum F. ♀, s.; (2) Ceratina dupla Say ♂♀, s., freq.; (3) C. tejonensis Cr. ♂, s.; (4) Alcidamea producta Cr. ♂, s.; (5) Osmia albiventris Cr. ♀, s., (6) Stelis lateralis Cr. ♂, s.; (7) Nomada annulata Cr. ♂, s.; (8) N. sayi Rob. ♂, s.; *Andrenidae:* (9) Andrena ziziae Rob. ♂♀, s., ab.; (10) H. pectoralis Sm. ♀, s.; (11) H. ligatus Say ♀, s.; (12) H. fasciatus Nyl. ♀, s.; (13) H. confusus Sm. ♀, s.; (14) Augochlora pura Say ♀, s. and c. p., ab.; (15) A. similis Rob. ♀, s.; ab.; (16) Sphecodes mandibularis Cr. ♀, s.; (17) Prosopis affinis Sm. ♂, s.; *Eumenidae:* (18–20) Odynerus spp., s., freq.; (21) O. anormis Say, s.

Diptera—*Syrphidae:* (22) Paragus tibialis Fll.; (23) Syritta pipiens L., s.; *Tachinidae:* (24) sp., s.; (25) Cistogaster occidua Wlk., s.; *Sarcophagidae:* (26) Sarcophaga sp., s.; *Muscidae:* (27) Lucilia sp., s.; *Anthomyidae:* (28) Chortophila sp., s.

Lepidoptera—*Nymphalidae:* (29) Phyciodes tharos Dru., s.

ROSA HUMILIS Marsh.— The flowers expand several centimetres. The stamens are turned outwards so strongly that insects landing near the center of the flower are likely to touch the stigmas before becoming dusted with pollen from the same flower. Nectar is wanting. The principal visitors are bumblebees and other large bees, which collect the pollen, and

a common beetle, *Trichius piger*, which feeds upon it. Small bees may collect the pollen without touching the stigmas.

The blooming time of *Rosa humilis* is from May 22 to July 8. *Anthophora abrupta* ♀, whose time of flight is from May 13 to the last of June, seems to depend for pollen almost exclusively upon this rose.

On twelve days, between May 22 and June 20, I observed the following visitors :—

Hymenoptera — *Apidae:* (1) Bombus virginicus Oliv. ♀ ; (2) B. americanorum F. ♀, ab.; (3) B. separatus Cr. ♀ ; (4) Anthophora abrupta Say ♀, ab.; (5) Synhalonia speciosa Cr. ♀ ; (6) Ceratina dupla Say ♀ ; *Andrenidae:* (7) Halictus confusus Sm. ♀ ; (8) Augochlora pura Say ♀ ; (9) Agapostemon viridula F. ♀ —all collecting pollen.

Coleoptera — *Scarabaeidae*: (10) Trichius piger F., ab.; *Chrysomelidae:* (11) Diabrotica 12-punctata Oliv.— both feeding on pollen.

Rosa setigera Michx. — The flowers resemble those of *Rosa humilis*, but the styles cohere in a column, which enables the stigmas to touch a visiting bumble-bee a little more readily. I have noted the flowers in bloom from June 16 to July 4. June 16 I saw them visited for pollen by (1) Bombus americanorum F. ♀ ; (2) Anthophora abrupta Say ♀ ; and (3) Trichius piger F.

Pyrus coronaria L. — During the blooming time — April 25 to May 16 — the trees are conspicuous with a profusion of rose-colored flowers. The attractiveness of the flowers is increased by their delicious fragrance.

The corollas expand from four to five centimetres. The receptacular tube extends nearly directly upwards from the ovary for a distance of about two millimetres. The summit of the tube is surmounted by a dense circle of filaments which are also directed upwards and a little inwards. In this way the nectar is effectually concealed and short-tongued and weak insects are excluded. The nectar is reached by a bee thrusting its proboscis between the separating ends of the filaments. The flowers are strongly proterogynous. In most of them the stigmas are protruded so far beyond the authers, that spontaneous self-pollination after the anthers begin to dehisce is impossible.

The deeply concealed nectar, the rose color and the large size of the flowers suggest adaptation to bumble-bees, which are, in fact, the principal visitors. The stamens and styles project so far that small insects would be quite unlikely to effect cross-pollination. Bumble-bees clasp the whole bunch of stamens between their legs. On May 5, 9 and 12 I observed the following visitors :—

Apidae: (1) **Apis mellifica L. ☿, s., freq.; (2) Bombus virginicus Oliv. ♀, s., ab.; (3) B. americanorum F. ♀, s., ab.; (4) B. pennsylvanicus DeG. ♀, s.; (5) B. separatus Cr. ♀, s., freq.; (6) Synhalonia speciosa Cr. ♂, s., freq.**

Lepidoptera — *Nymphalidae:* (7) **Danais archippus F., s., one;** *Hesperidae:* (8) **Nisoniades juvenalis F., s., one.**

CRATAEGUS COCCINEA L. v. MOLLIS Torr. and Gray. — The flowers appear with the leaves, and the trees are fairly white with the numerous corymbs. The flowers expand about two and one-half centimetres.

When the flowers open, the stigmas are found to be receptive, while the anthers are still closed. Later, when the anthers dehisce, there is a chance for self-pollination, with or without insect aid. The stamens, however, form a circle somewhat distant from the styles.

In *Pyrus coronaria* we have observed that the superior, nectar-bearing portion of the receptacular tube is produced directly upwards, forming a tube, whose mouth is concealed by the approximated filaments.

In *Crataegus* this part of the tube is expanded into a concave disc, and the filaments have no effect in concealing the nectar, which is sought by numerous short-lipped insects. Some very small insects can obtain the nectar without rendering any service in return by aiding in pollinating the flower. In this form the nectar-bearing disc measures six millimetres across. The flowers have a disagreeable odor, and sometimes the discs of the older flowers turn purplish.

In 1893 I found the flowers in bloom from April 26 to May 16. Although the blooming time of the variety overlaps with that of the typical form, there is little opportunity for intercrossing of the two, since one is going out of bloom while the other is coming in and they are in the most favor-

able condition for insect visits at different times. May 5 and 9,* principally on the former day, I captured the following visitors: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus americanorum F. ♀, s.; (3) Ceratina dupla Say ♂, s.; *Andrenidae:* (4) Andrena bicolor F. ♀, s.; (5) A. sayi Rob. ♀, s.; (6) A. cressonii Rob. ♂♀, s., freq.; (7) A. flavo-clypeata Sm. ♂♀, s., ab.; (8) A. rugosa Rob. ♂, s.; (9) A. forbesii Rob. ♀, s. and c. p.; (10) A. claytoniae Rob. ♂, s., freq.; (11) A. crataegi Rob. ♂♀, s., ab.; (12) Halictus arcuatus Rob. ♀, s.; (13) H. lerouxii Lep. ♀, s. and c. p., freq.; (14) H. cressonii Rob. ♀. s.; (15) H. zephyrus Sm. ♀, s. and c. p., ab.; (16) H. confusus Sm. ♀, s.; (17) H. stultus Cr. ♀, s. and c. p., ab.; (18) Augochlora pura Say ♀, s.; (19) Colletes inaequalis Say ♀, s.; *Vespidae:* (20) Vespa germanica F., s.; (21) Polistes metricus Say, s.; (22) P. pallipes Lep., s.; *Eumenidae:* (23) Odynerus tigris Sauss., s.

Diptera — *Conopidae:* (24) Myopa vesiculosa Say, s., ab.; *Syrphidae:* (25) Pipiza pistica Will.; (26) *Chrysogaster ustulata* Lw.; (27) Myiolepta strigillata Lw., freq.; (28) Eristalis dimidiatus Wd.; (29) Helophilus similis Mcq.; (30) Xylota fraudulosa Lw. — all s. and f. p.; *Tachinidae:* (31) Hyalomyia sp., s.; *Sarcophagidae:* (32) Cynomyia sp., s.; *Muscidae:* (33) Calliphora erythrocephala Mg., s.; (34) C. vomitoria L., s.; (35) Lucilia caesar L., s.; (36) L. cornicina F., s.; (37) Cyrtoneura sp., s.; *Anthomyidae:* (38) Chortophila sp., s.

Coleoptera — *Scarabaeidae:* (39) Euphoria fulgida F.; *Cerambycidae:* (40) Molorchus bimaculatus Say; *Chrysomelidae:* (41) Diabrotica vittata F.; *Oedemeridae:* (42) Asclera puncticollis Say — all s. or f. p.

Lepidoptera — *Nymphalidae:* (43) Grapta interrogationis F., s.

Crataegus coccinea L.—The flowers of this form agree in most essentials with those of the variety, but are more fragrant, smaller, grow in smaller cymes, and the nectar-bearing disc is more concave and narrow.

When the flowers open, the receptive stigmas are exposed above the anthers, which are still closed. The stamens are bent inwards over the disc. They turn outwards in succession, the outer ones discharging pollen first.

The flowers bloom from May 5 to 22. On the 9th and 12th, the following visitors were noted :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., freq.; (2) Bombus americanorum F. ♀, s., freq.; (3) B. virginicus Oliv. ♀, s.; (4) Ceratina dupla Say ♂, s.; (5) Nomada articulata Sm. ♂, s.; *Andrenidae:* (6) Andrena sayi Rob. ♀, s.; (7) A. perezi Rob. ♂, s.; (8) A. cressonii Rob.

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* I did not find the flowers under favorable conditions for insect visits after this date.

♂♀, s.; (9) A. flavo-clypeata Sm. ♂♀, s. and c. p., ab.; (10) A. ziziae Rob. ♂, s., freq.; (11) A. rugosa Rob. ♂, s.; (12) A. claytoniae Rob. ♂, s., freq.; (13) A. crataegi Rob. ♂♀, s., ab.; (14) Halictus lerouxii Lep. ♀, s.; (15) H. ligatus Say ♀, s.; (16) H. fasciatus Nyl. ♀, s., freq.; (17) H. zephyrus Sm. ♀, s., freq.; (18) H. confusus Sm. ♀, s.; (19) H. stultus Cr. ♀, s.; *Vespidae:* (20) Polistes metricus Say, s., freq.; (21) P. pallipes Lep., s.; *Scoliidae:* (22) Tiphia inornata Say, s.

Diptera — *Empidae:* (23) Empis sp., s.; *Bombylidae:* (24) Bombylius major L., s.; *Conopidae:* (25) Myopa vesiculosa Say, s.; *Syrphidae:* (26) Pipiza pistica Will.; (27) Psilota buccata Mcq.; (28) Syrphus ribesii L.; (29) Mesograpta geminata Say; (30) Myiolepta strigillata Lw., freq.; (31) Eristalis aeneus F.; (32) E. dimidiatus Wd.; (33) Helophilus similis Mcq.; (34) Mallota cimbiciformis Fll. — all s. or f. p.; *Tachinidae:* (35) Gonia frontosa Say, s.; *Sarcophagidae:* (36) Cynomyia sp., s.; (37–38) Sarcophaga spp., s.; *Muscidae:* (39) Calliphora erythrocephala Mg., s.; (40) Lucilia sp., s.; (41) L. caesar L., s.; (42) L. cornicina F., s., freq.; (43) Compsomyia macellaria F., s.; (44) Cyrtoneura sp., s.

Coleoptera — *Coccinellidae:* (45) Hippodamea 15 — maculata Muls., s.; (46) Coccinella sanguinea L., s.; *Scarabaeidae:* (47) Euphoria fulgida F., s.; *Cerambycidae:* (48) Molorchus bimaculatus Say, s., freq., in cop.; *Chrysomelidae:* (49) Diabrotica vittata F., f. p.; *Oedemeridae:* (50) Asclera puncticollis Say., f. p.

Lepidoptera — *Nymphalidae:* (51) Danais archippus F., s.; (52) Pyrameis huntera F., s.

Crataegus crus-galli L.— This species resembles the preceding. The trees are even more conspicuous with the white blossoms. It blooms later — May 20 to June 1 — and consequently shows an increase in Aculeate Hymenoptera. With the exception of No. 8, which was taken on May 29, all of the visitors were observed May 22.

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus virginicus Oliv. ♀, s.; (3) B. americanorum F. ♀, s.; (4) B. pennsylvanicus DeG. ♀, s.; (5) B. separatus Cr. ♀, s.; (6) Synhalonia speciosa Cr. ♂, s.; (7) Ceratina dupla Say ♂, s.; (8) Megachile infragilis Cr. ♂, s.; (9) Heriades philadelphi Rob. ♂, s.; (10) Panurgus (?) andrenoides Cr. ♀, s.; *Andrenidae:* (11) Andrena sp. ♀, s. and c. p.; (12) A. bicolor F. ♀, s. and c. p.; (13) A. sayi Rob. ♀, s. and c. p.; (14) A. cressonii Rob. ♂♀, s. and c. p., freq.; (15) A. flavo-clypeata Sm. ♂♀, s. and c. p., the most abundant visitor; (16) A. ziziae Rob. ♂♀, s. and c. p., ab.; (17) A. forbesii Rob. ♀, s. and c. p.; (18) A. claytoniae Rob. ♀, s. and c. p.; (19) A. crataegi Rob. ♂♀, s. and c. p., ab.; (20) Halictus gracilis Rob. ♀, s. and c. p., freq.; (21) H. pectoralis Sm. ♀, s. and c. p.; (22) H. fasciatus Nyl. ♀, s. and c. p., ab.; (23) H. pilosus Sm. ♀, s. and c. p.; (24) H. zephyrus Sm. ♀, s. and c. p.; (25) H. confusus Sm. ♀, s. and c. p., ab.; (26) H. stultus Cr. ♀, s. and c. p., ab.; (27) H. tegularis Rob. ♀, s. and c. p., freq.; (28) Augochlora similis Rob. ♀, s. and c. p., freq.; (29) Colletes inaequalis Say ♀, s. and c. p.; (30) Prosopis sp. ♂, s.; (31) P. affinis Sm. ♂♀, s., ab.;

(32) P. pygmaea Cr. ♂♀, s., ab.; *Vespidae:* (33) Polistes metricus Say, s.; *Eumenidae:* (34) Eumenes fraternus Say, s., freq.; (35) Odynerus walshianus Sauss., s.; (36) O. tigris Sauss., s.; (37) O. capra Sauss., s.; (38) O. foraminatus Sauss., s.; (39) O. anormis Say, s.; *Crabronidae:* (40) Crabro scutellatus Say, s.

Diptera — *Stratiomyidae*: (41) Stratiomyia discalis Lw., s.; *Syrphidae*: (42) Chrysogaster nitida Wd.; (43) Didea fasciata fuscipes Will.; (44) Xanthogramma emarginata Say; (45) Mesograpta geminata Say; (46) Volucella vesiculosa F.; (47) Eristalis dimidiatus Wd.; (48) E. latifrons Lw.; (49) E. transversus Wd.; (50) Helophilus similis Mcq.; (51) Mallota cimbiciformis Fll.; (52) Syritta pipiens L. — all s. or f. p.; *Sarcophagidae:* (53) Cynomyia sp., s.; (54) Sarcophaga sp., s.; *Muscidae:* (55) Cyrtoneura sp., s.; (56) Lucilia sp., s.; (57) Lucilia caesar L., s.; *Anthomyidae:* (58-59) Chortophila spp.; *Ortalidae:* (60) Camptoneura picta F., s.

Coleoptera — *Buprestidae:* (61) Acmaeodera culta Web., s.; *Scarabaeidae:* (62) Euphoria fulgida F., s.; *Cerambycidae:* (63) Molorchus bimaculatus Say, s.

Lepidoptera — *Nymphalidae:* (64) Danais archippus F.; *Lycaenidae:* (65) Lycaena pseudargiolus B. — L.; *Papilionidae:* (66) Papilio philenor L. — all s.

AMELANCHIER CANADENSIS Torr and Gr. — This is the earliest of the indigenous Rosaceae — blooming from April 1 to 27. In my neighborhood the small trees grow on high creek banks and are fairly white with the numerous flowers, which appear before the leaves. The flowers are crowded in short racemes terminating the branches. The oblong petals measure 12 or more mm. in length and are so closely interwoven with the petals of neighboring flowers that the more inconspicuous flower-stalks and calyces are concealed, and the outlines of the individual flowers are lost in the white mass. Nectar is secreted by that portion of the receptacular tube which lies between the ovary and the bases of the filaments. When the flower opens, the five styles, with their receptive stigmas, are exposed above the inflected stamens, whose anthers are still closed. The stamens straighten and turn outwards in succession, the anthers discharging their pollen in the same order. Five innermost stamens remain strongly inflected, with their large closed anthers obstructing the mouth of the tube until all of the other anthers have become emptied. The flowers are abundantly visited, and until the anthers dehisce, there is full opportunity, in all favorable weather, for the stigmas to receive pollen from other flowers of the same or of distinct trees. If such pollination does not

occur early, there is provision for spontaneous self-pollination, for by the closing of the petals at night, or in cloudy or rainy weather, the anthers of some of the longer stamens come in contact with the stigmas.

The flowers are pollinated by bees principally of the genus *Andrena*. On April 10th and 11th, I noted as visitors: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus ridingsii Cr. ♀; (3) Ceratina dupla Say ♂; *Andrenidae:* (4) Andrena sayi Rob. ♂♀, freq.; (5) A. salicis Rob. ♀; (6) A. illinoensis Rob. ♀; (7) A. cressonii Rob. ♂♀; (8) A. flavoclypeata Sm. ♂♀, ab.; (9) A. rugosa Rob. ♂; (10) A. forbesii Rob. ♀, freq.; (11) A. mariae Rob. ♂; (12) A. claytoniae Rob. ♂; (13) Halictus gracilis Rob. ♀; (14) H. pilosus Sm. ♀; (15) H. zephyrus Sm. ♀; (16) H. caeruleus Rob. ♀; (17) H. confusus Sm. ♀; (18) H. stultus Cr. ♀ — all sucking; *Tenthredinidae:* (19) Dolerus arvensis Say, s.

Diptera — *Syrphidae:* (20) Mesograpta marginata Say; (21) M. geminata Say; (22) Sphaerophoria cylindrica Say; (23) Eristalis aeneus F.; *Tachinidae:* (24) Phorocera edwardsii Will.; *Muscidae:* (25) Lucilia cornicina F. — all sucking.

Review of the preceding Rosaceae: — In table I the plants are given as nearly as practicable in the order in which they were observed, beginning with those blooming first. Little needs to be said of *Geum vernum* and *Rubus occidentalis*, which are sparingly visited by insects.

Spiraea aruncus strikes us as the most peculiar, since it shows a strong preponderance of Coleoptera. Beetles occur on nine species, but are not very important except in case of *Spiraea*.

Four species show a strong preponderance of bees. These are *Pyrus coronaria*, *Rubus villosus*, *Rosa humilis* and *setigera*. These are large flowers, forming a firm support for heavy insects, and requiring large insects readily to pollinate them. The two former have the nectar more deeply concealed than usual, so that it is only accessible to long tongues. The *Andrenidae* which I noted on *Rubus villosus* were only collecting pollen. The roses have no nectar, but yield abundant pollen, and are the largest and most attractive of all the flowers. These four species may be regarded as humble-bee flowers, though they are also less frequently visited by other large bees.

The other flowers have the nectar so situated that it is convenient for short-tongued insects, and these flowers agree in showing a preponderance of *Apidae*, *Andrenidae* and *Diptera*. Early in the spring the anthophilus insect-fauna consists mainly of these insects. Later in the season bees and flies come in competition with the lower Aculeate Hymenoptera, which become abundant. Accordingly, these insects show a larger proportion on the late flowering *Geum album* than on any other species. The earlier species show quite a number of bees of the genus *Andrena*. The time of flight of all of these species of *Andrena* is over before *Geum album* comes in bloom, and, consequently, the list of visitors shows none of them. *Andrenas* would be expected to occur on *Fragaria*, and probably do, but my list is quite fragmentary. Müller found one *Andrena* on *F. vesca*.

The usual colors of the Rosaceae are white (13 species, table II.) or yellow (5 cases), colors characterizing flowers adapted to miscellaneous insects. *Pyrus* and *Rosa* show marked departures from the ordinary colors, and, as noted above, are adapted to bumble-bees.

Except in the cases of the species adapted to *Apidae*, these bees are not very abundant on the flowers. Of the *Apidae* which fly throughout the season, we have *Apis* and *Ceratina*. *Bombus* females occur on the early species, and the workers appear later on *Rosa*. On the earlier flowers we find the early flying species, such as *Anthophora*, *Synhalonia*, *Osmia*, *Nomada* and *Panurgus?* Later species show *Phileremus*, *Stelis* and *Calliopsis*.

The flowers being of rather simple structure, with easily accessible nectar and numerous exposed stamens, are particularly well suited for the short-tongued bees — *Andrenidae*. These consist mainly of *Andrena* and *Halictus*. Early blooming species show the single early *Colletes inaequalis*. A little later we find *Agapostemon*, *Augochlora*, *Prosopis* and *Sphecodes* — a few species of each. The males of *Halictus*, and the allied genera *Agapostemon* and *Augochlora*, do not appear until late in the season. Accordingly, the early lists show nothing but females of these genera, and we find males of *Halictus* and *Augochlora* only on the late flowers of *Geum album*.

In table II. I have arranged the species which I have thus far found in my neighborhood (Carlinville, Ill.— 39° 21′), in the order in which they appear. At the bottom of the table we have the whole reduced to a curve for the *Rosaceae*. The parts of the table which seem to me the most defective are those giving the blooming periods of *Rubus*, *Rosa*, *Spiraea* and *Gillenia*. When these are more completely worked out, I think the curve will become more regular, giving a more evident maximum for May and June.

Amelanchier canadensis blooms first and almost entirely escapes competition, *Prunus americana* being the only competitor. The latter overlaps with the later period of the former and with the early part of the period of *P. serotina* and *Fragaria*. In May we have a time of strong competition. At the same time we have *Prunus serotina*, *Fragaria*, *Pyrus*, *Geum vernum*, *Crataegus coccinea* v. *mollis* and *C. coccinea*, and *Potentilla canadensis*. *Pyrus coronaria* avoids competition by attracting bumble-bees. *Geum vernum* seems to have the worst of the struggle and shows a strong tendency to avoid competition for the attention of insects by resorting to spontaneous self-pollination. *Potentilla canadensis* shows a strong disposition to overcome the disadvantage of this strong competition by lengthening its blooming time and extending it until the others have gone out. As far as other members of the order are concerned, the struggle for existence seems to favor the later blooming of this plant.

The three *Crataegi* have a sharp struggle among themselves. The severity of this contest is relieved by var. *mollis* coming first. *C. coccinea* fills the gap between the former and *C. crus-galli*. There is no rivalry between the first and the last.

In the period from the middle of May to the middle of June, competition is not so strong, though quite a number of species are in bloom at the same time. Pressure between *Rubus* and *Rosa* is relieved by the fact that the former is visited for nectar and the latter only for pollen. There must be a strong contest between *Rubus villosus* and *canadensis*, though the former seems to be earlier. *R. occidentalis* seems to incline to self-pollination, though it is visited by shorter-lipped insects. Among the roses, *R. humilis* is earliest, but my observations here are not complete.

Among the *Bombus*-flowers, *Pyrus* has everything its own way, while the contest is weak between *Rubus* and *Rosa*, but strong between the congeners of these genera.

In June *Spiraea* seems to depend upon beetles without being molested by its relatives. *Gillenia*, from its structure, seems to depend mainly upon small, long-tongued bees, but I hope to pay more attention to it next season.

Geum album is practically without competition, except with *Potentilla norvegica*, and *Agrimonia eupatoria* and *parviflora*. *Agrimonia eupatoria* was observed by Müller * to be visited for pollen by nine *Syrphidae*, one *Anthomyia* and one *Halictus*. I have yet to make observations on this species and *A. parviflora*.

Potentilla norvegica seems to depend mainly upon self-pollination. Its long blooming time may to some extent, compensate for its inconspicuousness and its inability to attract numerous insects at any given time. This species and *Agrimonia eupatoria* are the only species treated of here which are credited by the Manual to both this country and Europe. From its long blooming time it resembles an introduced species.

Tables III. and IV. give the results of the observation of the insect-visitors of the genera considered in this paper. The observations in Low Germany were taken from Müller's Fertilization of Flowers and Weitere Beobachtungen über Befruchtung der Blumen durch Insekten; those in the Alps from his Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassungen an Dieselben. The observations made in the Pyrenees are taken from MacLeod: De Pyreneeënbloemen en hare Bevruchting door Insecten, eene bijdrage tot de bloemengeographie.

COMPOSITAE.

The following paper on the insect visitors of the Compositae gives the results of observations made in the neighborhood of Carlinville, Illinois. Since hardly half of the species growing here are included, I have thought it better to withhold a general review of the family until at least most of the remaining species have been studied.

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* Fertilization of Flowers, 235.

In connection with plants having so many insect visitors it will be well to acknowledge the sources from which I have received aid. Early in my work Mr. E. T. Cresson kindly named my bees. Later I have determined them myself from descriptions, and through the kindness of Mr. Cresson have compared doubtful cases with the types in the collection of the American Entomological Society. I have worked up the local species of Andrenidae, and described the species which seemed to be new. Mr. W. H. Ashmead has kindly determined my Chalcididae, Braconidae and Ichneumonidae, though many of the Chalcids were determined by Mr. L. O. Howard. As regards the other Hymenoptera, I am responsible for the determinations, except in the case of a few species determined by Mr. Wm. J. Fox.

As regards the Diptera, Dr. S. W. Williston has identified most of the Bombylidae, Conopidae and Syrphidae, besides many other species of different families. Mr. D. W. Coquillett has determined the Empidae, etc., and Mr. C. H. T. Townsend most of the Tachinidae. Many Diptera I have lately determined for myself. Prof. G. H. French has aided me in the determination of Lepidoptera, Mr. P. R. Uhler and Mr. C. A. Hart have determined the Hemiptera. The Coleoptera were determined by Mr. Hart, except a few sent to Mr. Samuel Henshaw. In the more important anthophilous groups, I make it a rule to verify all determinations made for me, by comparison with the descriptions, whenever these are accessible.

Finally, I am indebted to Mr. Cresson for the interest he has always taken in the entomological part of my work, and to Prof. Wm. Trelease for friendly advice and kind encouragement as well as aid in gaining access to literature.

VERNONIA NOVEBORACENSIS Willd. — The stems are tall, and terminated by numerous heads arranged in a cyme. The heads are discoid. The florets are purple and have tubes nine or ten millimetres long. Pollen is carried out on the long hairy styles.

The visitors consist of long-tongued bees and flies, and butterflies. The flowers were observed in bloom from July

30 to September 26. On eight days, between August 17 and September 2, the following guests were noted: —

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♂♀, s., ab.; (2) B. pennsylvanicus DeG. ♀, s.; (3) B. separatus Cr. ♂, s.; (4) Melissodes perplexa Cr. ♂♀, s. and c. p., freq.; (5) M. obliqua Say ♀, s. and c. p.; (6) M. bimaculata Lep. ♂, s.; (7) Ceratina dupla Say ♀, s.

Lepidoptera — *Rhopalocera:* (8) Danais archippus F.; (9) Papilio turnus L.; (10) Pieris rapae L.; (11) Colias philodice Gdt., ab.; (12) Pamphila cernes B. — L.; (13) P. manataaqua Scud.; (14) P. metacomet Harr.; (15) Eudamus tityrus F. — all s.

Diptera — *Bombylidae:* (16) Exoprosopa fasciata Mcq., ab.; (17) Systoechus vulgaris Lw. — both s.

Eupatorium purpureum L. — The purplish color of the florets and the slender tubes seem to indicate an adaptation to butterflies, but the flowers are also visited by long-tongued Hymenoptera and Diptera.

The flowers bloom from August 4 to September 3. The list of visitors was observed August 4, 6–8: —

Lepidoptera — *Rhopalocera:* (1) Danais archippus F.; (2) Phyciodes nycteis D. — H., (3) Papilio philenor L.; (4) P. turnus L.; (5) Pieris rapae L.; (6) P. protodice B. — L.; (7) Colias philodice Gdt.; (8) Pamphila peckius Kby.; (9) Pholisora hayhurstii Edw. — all s.

Hymenoptera — *Apidae*: (10) Apis mellifica L. ☿; (11) Bombus pennsylvanicus DeG. ☿; (12) B. virginicus Oliv. ☿, freq.; (13) Melissodes bimaculata Lep. ♀; (14) M. aurigenia Cr. ♂; *Vespidae:* (15) Polistes rubiginosus Lep.; *Sphecidae:* (16) Ammophila gryphus Sm. — all s.

Diptera — *Bombylidae:* (17) Exoprosopa fasciata Mcq.; (18) Systoechus vulgaris Lw. — both s.; *Syrphidae:* (19) Volucella vesiculosa F., f. p.

Eupatorium serotinum Michx. — This is a common species, blooming from August 16 to Sept. 19. The tubes are shorter and broader than in *E. purpureum*, and consequently there are many more short-tongued species on the flowers. The following list was observed on August 24, 25, 27, 28, and September 19: —

Hymenoptera — *Apidae*: (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus virginicus Oliv. ♂ ☿, s. and c. p., freq.; (3) B. vagans Sm. ♀, s. and c. p.; (4) B. scutellaris Cr. ♂, s.; (5) Megachile brevis Say ♂, s.; (6) Heriades carinatum Cr. ♂♀, s. and c. p., freq.; *Andrenidae:* (7) Agapostemon viridula F. ♂, s.; (8) Halictus pectoralis Sm. ♂, s.; (9) H. coriaceus Sm. ♂ ♀, s.; *Vespidae:* (10) Vespa germanica F.; (11) Polistes metricus Say; *Eumenidae:* (12) Eumenes fraternus Say; (13) Odynerus sp.; (14) O.

campestris Sauss.; *Crabronidae:* (15) Thyreopus tumidus Pk.; *Philanthidae:* (16) Cerceris fulvipes Cr., freq.; *Larridae:* (17) Ancistromma distincta Sm., ab.; *Sphecidae:* (18) Ammophila vulgaris Cr.; (19) A. intercepta Lep.; (20) Pelopoeus cementarius Dru.; (21) Isodontia philadelphica Lep.; *Pompilidae:* (22) Pompilus sp.; *Scoliidae:* (23) Myzine sexcincta F.; (24) Scolia bicincta F.— all s.

Diptera — *Bombylidae:* (25) Anthrax alternata Say; (26) Sparnopolius fulvus Wd.; (27) Geron senilis F.; *Conopidae:* (28) Physocephala tibialis Say; *Syrphidae:* (29) Chrysogaster nitida Wd.; (30) Chilosia sp.; (31) Eristalis tenax L.; (32) Spilomyia longicornis Lw.; *Dexidae:* (33) Prosena sp.; *Tachinidae:* (34) Gymnosoma fuliginosa R. D.; (35) Wahlbergia arcuata Say; (36) Jurinia smaragdina Mcq.; (37) Acroglossa hesperidarum Will.; (38) Loewia nigrifrons Twns.— all s.

Lepidoptera — *Rhopalocera:* (39) Eudamus tityrus F.; *Heterocera:* (40) Carmenta pyralidiformis Wlk.— det. by French; (41) Scepsis fulvicollis Hbn.; (42) Feltia subgothica Steph.; (43) Spragueia leo Gn.— all s.

Coleoptera — *Lampyridae:* (44) Chauliognathus pennsylvanicus DeG., s.; *Scarabaeidae:* (45) Euphoria sepulchralis F., s.; *Cerambycidae:* (46) Cyllene robiniae Forst., f. p.; (47) C. decorus Oliv., f. p.; *Rhipiphoridae:* (48) Rhipiphorus limbatus F., s.

Eupatorium perfoliatum L. — Visitors observed on August 13, 25 and September 3:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀; *Andrenidae:* (2) Prosopis affinis Sm.; *Crabronidae:* (3) Crabro interruptus Lep., freq.; (4) Oxybelus frontalis Rob.; *Philanthidae:* (5) Eucerceris zonatus Say; *Sphecidae:* (6) Pelopoeus cementarius Dru.; *Scoliidae:* (7) Myzine interrupta Say, ab.— all s.

Diptera — *Empidae:* (8) Empis sp., s.; *Tachinidae:* (9) Cistogaster occidua Wlk.; (10) Siphophagia anomala Twns.— all s.

Coleoptera — *Meloidae:* (11) Epicauta pennsylvanica De G., f. p.; *Rhipiphoridae:* (12) Rhipiphorus limbatus F., s.

Eupatorium ageratoides L.—Visitors observed September 2, 10, 12:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s. and c. p., ab.; *Andrenidae:* (2) Halictus ligatus Say ♂♀, s., freq.; (3) H. fasciatus Nyl. ♂, s.; (4) Augochlora pura Say ♀, s.; *Vespidae:* (5) Vespa maculata L., s.; *Eumenidae:* (6) Odynerus tigris Sauss., s.; *Larridae:* (7) Ancistromma distincta Sm., s.; *Scoliidae:* (8) Scolia bicincta F., s.

Diptera — *Bombylidae:* (9) Exoprosopa fasciata Mcq.; *Syrphidae:* (10) Allograpta obliqua Say; *Tachinidae:* (11) Cistogaster occidua Wlk.; *Dexidae:* (12) Rhynchodexia sp.; *Muscidae:* (13) Lucilia cornicina F.— all s.

Lepidoptera — *Lycaenidae:* (14) Lycaena pseudargiolus B. — L.; *Ctenuchidae:* (15) Scepsis fulvicollis Hbn. — both s.

LIATRIS PYCNOSTACHYA Michx. — The plants grow on prairies and are often collected in conspicuous patches. The stems rise from eight to sixteen decimetres high and bear long spikes of heads, each one of which contains five or six rose-purple flowers.

All of the flowers are perfect. Pollen is carried out and exposed on the long divisions of the style. The corolla tubes are from seven to eight millimetres long. The visitors are long-tongued bees and flies, and butterflies. By far the most abundant visitor observed by me is *Exoprosopa fasciata*.

Liatris pycnostachya blooms from July 21 to August 14. The following visitors were observed on August 9 and 10:—

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♂♀, s. and c. p., freq.; (2) B. virginicus Oliv. ♀, s. and c. p.; (3) B. separatus Cr. ♂ ♀, s., freq.; (4) Melissodes coloradensis Cr. ♂, s.; (5) M. obliqua Say ♂♀, s. and c. p., freq.; (6) M. aurigenia Cr. ♂♀, s., freq., (7) Ceratina dupla Say ♀, s., freq.; (8) Megachile latimanus Say ♂♀, s., freq.; (9) M. inimica Cr. ♀, s. and c. p.; (10) Epeolus remigatus F. ♂♀, s.; *Andrenidae:* (11) Halictus ligatus Say ♀, c. p., freq.; (12) Agapostemon viridula F. ♂♀, s., freq.

Lepidoptera — *Rhopalocera:* (13) Danais archippus F.; (14) Argynnis idalia Dru.; (15) Pieris rapae L.; (16) Colias philodice Gdt., freq.; (17) Papilio asterias F.; (18) P. philenor L.; (19) Pamphila peckius Kby., freq.; (20) P. cernes B.—L., freq.; (21) P. metacomet Harr.; (22) Eudamus tityrus F.; *Ctenuchidae:* (23) Scepsis fulvicollis Hbn.—all s.

Diptera — *Bombylidae:* (24) Exoprosopa fasciata Mcq., very ab.; (25) Systoechus vulgaris Lw.; *Conopidae:* (26) Physocephala texana Will.; (27) Stylogaster biannulata Say — all s.

SOLIDAGO MISSOURIENSIS Nutt.— Visitors observed on August 9, 17, 19:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s., one; (2) Melissodes obliqua Say ♀, s. and c. p., freq.; (3) M. perplexa Cr. ♀, s. and c. p.; (4) Ceratina dupla Say ♂, s.; *Andrenidae:* (5) Halictus pectoralis Sm. ♀, s. and c. p.; (6) H. ligatus Say ♀, s. and c. p., ab.; (7) H. fasciatus Nyl. ♀, s.; (8) H. confusus Sm. ♂♀, s. and c. p., freq.; (9) H. albipennis Rob. ♀, s. and c. p.; (10) H. tegularis Rob. ♀, s. and c. p.; (11) Augochlora similis Rob. ♀, s.; (12) Prosopis pygmaea Cr. ♀, s., freq.; *Vespidae:* (13) Polistes pallipes Lep., s.; *Eumenidae:* (14) Eumenes fraternus Say, s.; (15) Odynerus arvensis Sauss., s., freq.; (16) O. vagus Sauss., s.; (17) O. anormis Say, s.; *Crabronidae:* (18) Crabro interruptus Lep., s.; (19) C. chrysarginus Lep., s.; (20) Oxybelus frontalis Rob., s.; *Philanthidae:* (21) Philanthus ventilabris F., s.; (22) Eucerceris zonatus Say, s.; (23) Cerceris

compacta Cr., s., *Larridae:* (24) Ancistromma distincta Sm., s., freq.; *Sphecidae:* (25) Ammophila vulgaris Cr., s.; (26) A. intercepta Lep., s.; (27) A. pictipennis Walsh, s.; (28) Sphex pennsylvanica L., s.; (29) S. ichneumonea L., s.; (30) Prionony x thomae F., s.; *Scoliidae:* (31) Myzine sexcincta F., s., ab.; (32) M. interrupta Cr., s.; (33) Scolia bicincta F., s.; *Chrysididae:* (34) Hedychrum violaceum wiltii Cr., s., ab.; *Chalcididae:* (35) Perilampus cyaneus Brullé, s.; *Braconidae:* (36) Microdus simillimus Cr., s.; *Ichneumonidae:* (37) Ceratosoma fasciata Cr., s., freq.

Diptera — *Bombylidae:* (38) Exoprosopa fascipennis Say, freq.; *Syrphidae:* (39) Syritta pipiens L.; *Tachinidae:* (40) sp.; (41) Gymnosoma fuliginosa R. D.; (42) Siphoplagia anomala Twns.; (43) Miltogramma cinerascens Twns., freq.; (44) M. argentifrons Twns.; (45) M. flavicornis Twns.; (46) Gymnoprosopa clarifrons Twns.; *Dexidae:* (47) Scotiptera sp.; *Sarcophagidae:* (48) sp.; (49) Sarcophaga sp. — all s.

Coleoptera — *Lampyridae:* (50) Chauliognathus pennsylvanicus DeG., f.p.; *Chrysomelidae:* (51) Diabrotica 12-punctata Oliv., f. p.; *Meloidae:* (52) Epicauta pennsylvanica DeG., f. p., and gnawing, very ab. and destructive; *Rhipiphoridae:* (53) Myodites fasciatus Say, s.

Hemiptera — *Lygaeidae:* (54) Lygaeus turcicus F., s.

SOLIDAGO CANADENSIS L.*— Visitors — August 8, 25, 27, September 15, 18, 23, 26, 30, October 3, 7, and 10:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s. and c. p., ab.; (2) Bombus virginicus Oliv. ♂♀, s. and c. p., freq.; (3) B. vagans Sm. ♂, s.; (4) B. americanorum F. ♂♀, s., ab.; (5) B. scutellaris Cr. ♂♀, s.; (6) B. separatus Cr. ♂♀, s., freq., (7) Melissodes sp., s. and c. p.; (8) M. desponsa Sm. ♀, c. p.; (9) M. perplexa Cr. ♀, s. and c. p.; (10) Heriades carinatum Cr. ♀, s.; (11) Caliopsis solidaginis Rob. ♀, s. and c. p.; *Andrenidae:* (12) Andrena solidaginis Rob. ♀, s. and c. p., ab.; (13) Halictus coriaceus Sm. ♀, s. and c. p.; (14) H. forbesii Rob. ♀, s. and c. p.; (15) H. ligatus Say ♀, s. and c. p.; (16) H. lerouxii Lep. ♀, s.; (17) H. confusus Sm. ♂, s., ab.; (18) H. albipennis Rob. ♀, s. and c. p.; (19) Colletes americana Cr. ♂♀, s. and c. p., ab.; (20) C. spinosa Rob. ♀, s. and c. p.; (21) C. compacta Cr. ♀, s.; (22) Prosopis affinis Sm. ♀, s. and f. p., ab.; *Vespidae:* (23) Polistes metricus Say, ab.; (24) P. annularis L., ab.; (25) P. pallipes Lep., ab.; (26) P. rubiginosus Lep.; *Eumenidae:* (27) Eumenes fraternus Say; (28) Odynerus tigris Sauss., ab.; (29) O. capra Sauss., ab.; (30) O. catskillensis Sauss.; (31) O. arvensis Sauss.; (32) O. foraminatus Sauss.; (33) O. anormis Say; (34) O. sp.; *Crabronidae:* (35) Crabro 10-maculatus Say; (36) C. interruptus Lep.; *Mimesidae:* (37) Mimesa denticulata Pk.; *Philanthidae:* (38) Eucerceris zonatus Say; (39) Cerceris fulvipes Cr., freq.; (40) C. clypeata Dlb.; (41) C. finitima Cr.; (42) C. compacta Cr.; *Larridae:* (43) Ancistromma distincta Sm., freq.; (44) Tachysphex acuta Pttn.; *Sphecidae:* (45) Ammophila vulgaris Cr.; (46) Pelopoeus cementarius Dru.; (47) Isodontia philadelphica Lep.; (48) Sphex ichneumonea L.; (49) S. pennsylvanica L.;

* See Müller: Fertilization of Flowers, 321, & Weitere Beobachtungen III, 92.

(50) Prionony**x** thomae F.; (51) P. atrata Lep.; *Pompilidae:* (52) Pompilus relativus Fox; (53) P. sp.; (54) P. subviolaceus Cr.; (55) P. biguttatus F.; (56) P. marginatus Say; (57) P. interruptus Say; (58) P. navus Cr.; (59) Priocnemis agenioides Fox; (60) P. fulvicornis Cr.; (61) Ceropales elegans Cr.; (62) C. bipunctata Say; (63) C. fulvipes Cr.; *Scoliidae:* (64) Myzine 6-cincta F.; (65) Scolia nobilitata F.; (66) S. bicincta F.; *Chalcididae:* (67) Perilampus platygaster Say; (68) P. fulvicornis Ashm.; *Braconidae:* (69) Iphiaulax rugator Say, ab.; (70) Bracon simplex Cr.; (71) B. vernoniae Ashm.; (72) Chelonus sericeus Say, (73) Apanteles sp.; (74) Agathis sp.; (75) A. areolata Ashm., freq.; *Ichneumonidae:* (76) Limneria eurycreontis Ashm.; (77) Cremastus retiniae Cr.; (78) Lampronota americana Cr.; (79) L. varia Cr.

Diptera—*Bombylidae:* (80) Exoprosopa fascipennis Say; (81) Sparnopolius fulvus Wd.; (82) Geron senilis F.; (83) Toxophora amphitea Wlk.; *Conopidae:* (84) Physocephala texana Will.; (85) Zodion fulvifrons Say; (86) Oncomyia loraria Lw.; *Syrphidae:* (87) Paragus bicolor F.; (88) Chrysogaster nitida Wd., f. p.; (89) Chilosia sp.; (90) Platychirus hyperboreus Staeg. (?); (91) P. quadratus Say; (92) Xanthogramma divisa Will.; (93) Allograpta obliqua Say; (94) Mesograpta geminata Say; (95) Eristalis tenax L.; (96) E. dimidiatus Wd., ab.; (97) E. latifrons Lw.; (98) E. bastardi Mcq.; (99) Helophilus similis Mcq., ab.; (100) H. latifrons Lw.; (101) Tropidia mamillata Lw., freq.; (102) Syritta pipiens L.; (103) Spilomyia longicornis Lw.; (104) S. quadrifasciata Say; *Tachinidae:* (105) Cistogaster occidua Wlk.; (106) Gymnosoma fuliginosa R. D.; (107) Ennyomma clistoides Twns.; (108) Phasioclista metallica Twns.; (109) Loewia nigrifrons Twns.; (110) Trixoclista distincta Twns.; (111) Euryceromyia robertsonii Twns.; *Sarcophagidae:* (112–114) Sarcophaga spp.; *Muscidae:* (115) Graphomyia sp.; (116) Lucilia cornicina F., s. and f. p., ab.; (117) Compsomyia macellaria F., f. p., freq.; (118) Stomoxys calcitrans L., s.; *Anthomyidae:* (119) Anthomyia albicincta Fll.; (120) Chortophila sp.; *Trypetidae:* (121) Trypeta humilis Lw.

Coleoptera — *Carabidae:* (122) Callida punctata Lec.; *Coccinellidae:* (123) Megilla maculata DeG., f. p.; (124) Hippodamea glacialis F., freq.; (125) Coccinella 9-notata Hbst.; *Lampyridae:* (126) Chauliognathus pennsylvanicus DeG., f. p., ab.; *Malachidae:* (127) Collops 4-maculatus F.; *Scarabaeidae:* (128) Euphoria sepulchralis F., f. p., ab.; *Cerambycidae:* (129) Cyllene robiniae Forst., f. p., freq.; (130) C. decorus Oliv., f. p.; *Chrysomelidae:* (131) Diabrotica 12-punctata Oliv., f. p., ab.; (132) D. vittata F., f. p.; (133) D. longicornis Say, f. p., ab.; *Bruchidae:* (134) Bruchus obsoletus Say; *Meloidae:* (135) Epicauta pennsylvanica De G., f. p., ab.

Lepidoptera — *Rhopalocera:* (136) Danais archippus F.; (137) Pyrameis cardui L.; (138) Chrysophanus thoe B. — L.; (139) Colias philodice Gdt.; *Heterocera:* (140) Scepsis fulvicollis Hbn.; (141) Feltia subgothica Steph.; (142) Carneades velleripennis Grt.; (143) Heliothis armiger Hbn., ab.

Hemiptera — *Coreidae:* (144) Alydus pilosulus Schf., s.; *Lygaeidae:* (145) Lygaeus turcicus F., s.; *Capsidae:* (146) Calocoris rapidus Say, s.

SOLIDAGO NEMORALIS Ait. — Visitors observed September 26 and October 5 and 9 :—

Hymenoptera — *Apidae*: (1) Apis mellifica L. ☿, s.; (2) Bombus virginicus Oliv. ☿, s.; (3) B. americanorum F. ♂♀☿, s.; (4) Ceratina dupla Say ♂♀, s., freq.; (5) Megachile brevis Say ♀, s.; (6) Epeolus mercatus F. ♀, s.; (7) Calliopsis compositarum Rob. ♀, s.; (8) C. asteris Rob. (MS) ♀, s. and c. p.; *Andrenidae*: (9) Andrena nubecula Sm. ♀, s. and c. p., freq.; (10) Halictus sp. ♀, s.; (11) H. pectoralis Sm. ♀, s.; (12) H. ligatus Say ♂, s.; (13) H. cressonii Rob. ♂, s.; (14) H. confusus Sm. ♂♀, s. and c. p., freq.; (15) Augochlora similis Rob. ♀, s.; (16) Colletes compacta Cr. ♀, s. and c. p.; (17) C. americana Cr. ♂♀, s. and c. p., ab.; (18) C. eulophi Rob. ♀, s. and c. p.; (19) Prosopis pygmaea Cr. ♀, s., freq.; *Vespidae*: (20) Polistes rubiginosus Lep.; (21) P. pallipes Lep., freq.; (22) P. metricus Say, freq.; (23) P. annularis L.; *Eumenidae*: (24) Odynerus sp.; (25) O. tigris Sauss ; (26) O. foraminatus Sauss.; (27) O. anormis Say; *Crabronidae*: (28) Crabro interruptus Lep., freq.; (29) C. rufifemur Pk.; *Mimesidae*: (30) Mimesa denticulata Pk.; *Philanthidae*: (31) Philanthus punctatus Say; (32) Cerceris clypeata Dahlb.; (33) C. finitima Cr.; (34) C. kennicottii Cr.; *Larridae*: (35) Ancistromma distincta Sm.; *Sphecidae*: (36) Ammophila gryphus Sm.; (37) A. vulgaris Cr.; (38) A. pictipennis Walsh; *Pompilidae*: (39) Pompilus sp.; (40) P. marginatus Say; (41) Ceropales fulvipes Cr.; *Chrysididae*: (42) Chrysis perpulchra Cr.; *Braconidae*: (43) Chelonus sericeus Say — all s.

Diptera — *Bombylidae*: (44) Systropus macer F., s.; *Syrphidae*: (45) Syrphus americanus Wd.; (46) S. arcuatus Fll.; (47) Sphaerophoria cylindrica Say; (48) Spilomyia longicornis Lw.; (49) Syritta pipiens L. — all s. or f. p.; *Tachinidae*: (50) sp.; (51) Gymnosoma fuliginosa R. D.; (52) Jurinia smaragdina Mcq.; (53) Sarcomacronychia aurifrons Twns., freq.; *Sarcophagidae*: (54 and 55) spp.; *Muscidae*: (56) sp.; (57) Stomoxys calcitrans L.; (58) Lucilia sp.; (59) L. cornicina F.; (60) L. latifrons Schin.; (61) Compsomyia macellaria F.; *Trypetidae*: (62) Trypeta solaris Lw.; (63) T. humilis Lw.; *Oscinidae*: (64) Chlorops sp. — all s.

Lepidoptera — *Rhopalocera*; (65) Danais archippus F.; (66) Colias philodice Gdt.; (67) Terias lisa B. — L.; *Heterocera*: (68) Scepsis fulvicollis Hbn.; (69) Utetheisa bella L.; (70) Heliothis armiger Hbn. — all s.

Coleoptera — *Coccinellidae*: (71) Coccinella 9-notata Hbst.; *Lampyridae*: (72) Chauliognathus pennsylvanicus DeG.; *Cerambycidae*: (73) Cyllene robiniae Forst.; *Meloidae*: (74) Epicauta pennsylvanica DeG., ab., in cop. — all f. p.

Hemiptera — *Coreidae*: (75) Alydus pilosulus Schf.; *Capsidae*: (76) Lygus pratensis L.— both s.

SOLIDAGO LANCEOLATA L.— Visitors — September 6, 8, 9, 12, 13, and 25 :—

Hymenoptera — *Apidae*: (1) Apis mellifica L. ☿, s. and c. p., ab.; (2) Bombus virginicus Oliv. ☿, c. p., freq.; (3) B. americanorum F. ♂☿, s., freq.; (4) B. scutellaris Cr. ☿, s.; (5) B. separatus Cr. ♂, s.; (6) Melis-

sodes perplexa Cr. ♀, c. p., freq.; *Andrenidae:* (7) Andrena solidaginis Rob. ♀, s.; (8) Halictus ligatus Say ♀, s. and c. p.; (9) H. confusus Sm. ♀, c. p.; (10) Colletes spinosa Rob. ♀, c. p.; *Vespidae:* (11) Polistes metricus Say; (12) P. pallipes Lep.; *Eumenidae:* (13) Odynerus tigris Sauss.; (14) O. capra Sauss., ab.; (15) O. catskillensis Sauss.; *Crabronidae:* (16) Crabro 10-maculatus Say; *Philanthidae:* (17) Eucerceris zonatus Say; *Bembecidae:* (18) Megastizus brevipennis Walsh; (19) Bembex nubillipennis Cr.; *Larridae:* (20) Ancistromma distincta Sm.; *Sphecidae:* (21) Prionopyx atrata Lep.; *Pompilidae:* (22) Priocnemis fulvicornis Cr.; *Scoliidae:* (23) Myzine sexcincta F.; (24) Scolia bicincta F.;—all s.

Diptera—*Syrphidae:* (25) Sphaerophoria cylindrica Say; (26) Helophilus similis Mcq., ab.; (27) H. latifrons Lw.; *Tachinidae:* (28) Cistogaster occidua Wlk.; (29) Miltogramma flavicornis Twns.; (30) Atrophopoda singularis Twns.; *Muscidae:* (31) Lucilia cornicina F.; (32) Compsomyia macellaria F.—all s. or f. p.

Lepidoptera—*Rhopalocera:* (33) Phyciodes tharos Dru.; (34) Pyrameis huntera F.; (35) Chrysophanus thoe B.—L.; (36) Lycaena comyntas Gdt.; (37) Colias philodice Gdt.; *Heterocera:* (38) Utetheisa bella L.; (39) Heliothis armiger Hbn.; (40) Crambus laqueatellus Clem.—all s.

Coleoptera—*Lampyridae:* (41) Chauliognathus pennsylvanicus De G., f. p., ab.; *Meloidae:* (42) Epicauta pennsylvanica De G., f. p., ab.

Boltonia asteroides L'Her.— The plants are often collected in rather large patches in moist places, and are quite attractive to insects. The heads have yellow disc florets and white rays, and expand fifteen millimetres or more. The rays are pistillate, the disc florets being perfect. Nectar and pollen are supplied by the latter. The tubes of the disc florets are only about one millimetre deep, so that numerous short-tongued insects can obtain the nectar.

The list of visitors was observed September 20, 28, October 2 and 4:—

Hymenoptera—*Apidae:* (1) Bombus americanorum F. ♀, s.; (2) Melissodes sp. ♀, s.; (3) M. confusa Cr. ♀, s. and c. p.; (4) Megachile mendica Cr. ♀, s.; (5) M. brevis Say ♀, s.; (6) Calliopsis compositarum Rob. ♂♀, s. and c. p., ab.; (7) C. solidaginis Rob. ♀, s.; *Andrenidae:* (8) Andrena solidaginis Rob. ♂♀, s. and c. p.; (9) Halictus ligatus Say ♂♀, s.; (10) H. confusus Sm. ♂♀, s. and c. p., freq.; (11) Agapostemon radiatus Say ♀, s.; (12) Sphecodes mandibularis Cr. ♀, s.; (13) Colletes americana Cr. ♂♀, s. and c. p., ab.; (14) Prosopis affinis Sm. ♂, s.; (15) P. pygmaea Cr. ♂♀, s.; *Vespidae:* (16) Polistes pallipes Lep., s.; *Eumenidae:* (17) Odynerus anormis Say, s.; *Sphecidae:* (18) Prionopyx thomae F., s.

Diptera—*Bombylidae:* (19) Sparnopolius fulvus Wd., s.; *Conopidae:* (20) Oncomyia loraria Lw., s.; *Syrphidae:* (21) Paragus tibialis Fll.; (22) Syrphus americanus Wd.; (23) Mesograpta marginata Say; (24) Sphaerophoria cylindrica Say; (25) Eristalis dimidiatus Wd.; (26) Syritta pipiens L.—

all s. or f. p.; *Tachinidae:* (27) sp.; (28) Hyalomyia purpurascens Twns., freq.; (29) Gymnosoma fuliginosa R. D.; (30) Cistogaster occidua Wlk.; (31) C. immaculata Mcq.; (32) Miltogramma cinerascens Twns., freq.; (33) M. flavicornis Twns.; (34) M. argentifrons Twns.; (35) Sarcomacronychia aurifrons Twns.; (36) Acroglossa hesperidarum Will., freq.; (37) Leucostoma atra Twns.; *Sarcophagidae:* (38) sp.; (39) Sarcophaga sp.; *Muscidae:* (40) Compsomyia macellaria F.; *Anthomyidae:* (41) sp.; (42) Anthomyia sp.; *Trypetidae:* (43) Trypeta humilis Lw., ab.; *Sepsidae:* (44) Sepsis sp.—all s.

Lepidoptera — *Rhopalocera:* (45) Phyciodes tharos Dru.; (46) Colias philodice Gdt.; (47) Pamphila phylaeus Dru.; *Heterocera:* (48) Scepsis fulvicollis Hbn.; (49) Utetheisa bella L.; (50) Heliothis armiger Hbn.—all s.

Coleoptera — *Coccinellidae:* (51) Hippodamea parenthesis Say; *Lampyridae:* (52) Chauliognathus pennsylvanicus DeG.; *Chrysomelidae;* (53) Diabrotica longicornis Say, freq.; (54) D. 12-punctata Oliv., freq.—all f. p.

Hemiptera — *Capsidae:* (55) Lygus pratensis L., s.

ASTER NOVAE-ANGLIAE L.— The plants often grow in rather large patches and bear numerous showy heads with yellow discs and violet purple rays. The heads expand two and three centimetres. Nectar and pollen are supplied by the disc florets. The tubes of these measure three or four millimetres in length.

The visitors observed October 2, 4, 7, 8 and 10 are as follows:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s. and c. p.; (2) Bombus americanorum F. ♂☿☿, s. and c. p., freq.: (3) B. virginicus Oliv. ♂, s.; (4) B. separatus Cr. ♂, s.; (5) Melissodes desponsa Sm. ☿, s. and c. p.; (6) M. confusa Cr. ☿, s. and c. p.; (7) M. perplexa Cr. ☿, s. and c. p.; (8) M. aurigenia Cr. ☿, s. and c. p.; (9) Ceratina dupla Say ☿, s. and c. p.; (10) Megachile latimanus Say ☿, s. and c. p., freq.; (11) M. brevis Say ☿, s. and c. p., freq.; (12) Calliopsis compositarum Rob. ☿, c. p.; *Andrenidae:* (13) Andrena solidaginis Rob. ☿, c. p.; (14) A. helianthi Rob. ☿, c. p.; (15) Halictus parallelus Say ♂, s.; (16) H. ligatus Say ♂, s.; (17) Colletes americana Cr. ☿, c. p.

Lepidoptera — *Rhopalocera:* (18) Danais archippus F.; (19) Phyciodes tharos Dru.; (20) Pyrameis cardui L.; (21) Pieris protodice B.— L. (22) Colias philodice Gdt., ab.; (23) Meganostoma caesonia Stoll; (24) Pamphila peckius Kby.; (25) P. phylaeus Dru.; *Heterocera:* (26) Plusia simplex Gn.; (27) Heliothis armiger Hbn.— all s.

Diptera—*Conopidae:* (28) Stylogaster biannulata Say, s., freq.; *Syrphidae:* (29) Syrphus americanus Wd., f. p.; (30) Eristalis dimidiatus Wd., s.; (31) E. latifrons Lw., s.; (32) E. tenax L., s. and f. p.; (33) E. transversus Wd., s.; (34) Helophilus similis Mcq., s.; (35) Tropidia mamillata Lw., f. p.

ASTER PANICULATUS Lam.—Visitors—October 8, 9, 11, 17:—

Hymenoptera—*Apidae:* (1) Apis mellifica L. ♀, s., ab.; (2) Bombus virginicus Oliv. ♂, s., freq.; (3) B. americanorum F. ♀, s.; (4) Melissodes confusa Cr. ♀, s. and c. p.; (5) M. perplexa Cr. ♀, s. and c. p.; (6) Ceratina dupla Say ♀, s.; (7) Megachile latimanus Say ♀, s.; (8) M. brevis Say ♂♀, s. and c. p.; (9) Coelioxys altilis Cr. ♀, s.; (10) Heriades carinatum Cr. ♀, s.; (11) Calliopsis compositarum Rob. ♀, s. and c. p.; *Andrenidae:* (12) Andrena solidaginis Rob. ♀, s.; (13) A. asteris Rob. ♀♂, s.; (14) A. nubecula Sm. ♀, s.; (15) Agapostemon radiatus Say ♂, s.; (16) Augochlora similis Rob. ♀, s.; (17) Halictus pectoralis Sm. ♀, s.; (18) H. coriaceus Sm. ♂, s.; (19) H. forbesii Rob. ♂, s.; (20) H. lerouxii Lep. ♀, s.; (21) H. ligatus Say ♂♀, s., ab.; (22) H. fasciatus Nyl. ♀, s.; (23) H. zephyrus Sm. ♀, s.; (24) H. confusus Sm. ♂♀, s. and c. p.; (25) H. stultus Cr. ♀. s. and c. p., ab.; (26) Sphecodes dichroa Sm. ♂, s.; (27) Colletes compacta Cr. ♀, s.; (28) C. americana Cr. ♀, s.; (29) Prosopis pygmaea Cr. ♀, s.; *Vespidae:* (30) Vespa maculata L.; (31) V. germanica F.; (32)Polistes rubiginosus Lep., ab.; (33) P. metricus Say; (34) P. pallipes Lep.; *Eumenidae:* (35) Eumenes fraternus Say; (36) Odynerus tigris Sauss.; (37) O. capra Sauss.; (38) O. catskillensis Sauss.; (39) O. arvensis Sauss.; (40) O. foraminatus Sauss.; (41) O. anormis Say; (42) O. sp.; *Philanthidae:* (43) Philanthus politus Say; (44) P. punctatus Say; (45) Eucerceris zonatus Say; (46) Cerceris clypeata Dlb.; *Larridae:* (47) Notogonia argentata Bv.; *Sphecidae:* (48) Ammophila gryphus Sm.; (49) A. vulgaris Cr.; (50) A. intercepta Lep.; (51) A. gracilis Lep.; (52) Isodontia philadelphica Lep.; *Pompilidae:* (53) Pompilus biguttatus F.; *Scoliidae:* (54) Myzine sexcincta F.; *Chalcididae:* (55) Torymus sp.; *Braconidae:* (56) Bracon longicaudus Prov.; *Ichneumonidae:* (57) Lampronota varia Cr. — all s.

Diptera — *Conopidae:* (58) Oncomyia loraria Lw.; *Syrphidae:* (59) Syrphus americanus Wd.; (60) S. ribesii L.; (61) Mesograpta marginata Say; (62) M. geminata Say; (63) Sphaerophoria cylindrica Say; (64) Eristalis tenax L.; (65) E. aeneus F.; (66) E. dimidiatus Wd.; (67) E. transversus Wd.; (68) Syritta pipiens L.; (69) Spilomyia quadrifasciata Say; *Tachinidae:* (70) Hyalomyia robertsonii Twns.; (71) Trichopoda pennipes F.; (72) Jurinia smaragdina Mcq.; (73) Micropalpus fulgens Mg.; (74) Acroglossa hesperidarum Will.; (75) Miltogramma cinerascens Twns.; *Sarcophagidae:* (76) Sarcophaga sp.; *Muscidae:* (77) Stomoxys calcitrans L.; (78) Graphomyia sp.; (79 and 80) Lucilia spp.; (81) L. caesar L.; (82) L. latifrons Schin.; (83) L. cornicina F.; (84) Compsomyia macellaria F. — all s. or f. p.

Lepidoptera — *Rhopalocera:* (85) Phyciodes tharos Dru.; (86) Pyrameis cardui L.; (87) P. huntera F.; (88) Lycaena pseudargiolus B. — L.; (89) Pieris rapae L.; (90) P. protodice B. — L.; (91) Colias philodice Gdt.; (92) Pamphila peckius Kby.; (93) P. campestris Bdv., var. huron Edw.; (94) Nisoniades martialis Scud.; *Heterocera:* (95) Scepsis fulvicollis Hbn.; (96) Plusia simplex Gn. — all s.

Coleoptera — *Lampyridae:* (97) Chauliognathus pennsylvanicus De G.; *Scarabaeidae:* (98) Euphoria sepulchralis F.; *Cerambycidae:* (99) Cyllene robiniae Forst.

Hemiptera — *Coreidae:* (100) Alydus eurinus Say, s.

ERIGERON PHILADELPHICUS L. — The stems grow a few decimetres high and expose several heads which expand about two centimetres. The ray florets are pistillate, are very numerous and slender and white, or purplish tinted. The disc florets are yellow. The tubes are very narrow and measure about four millimetres in length. The nectar is easily obtained by small, long-tongued insects which find a convenient resting-place upon the disc. Pollen is forced out of the anther tube in the usual way.

The flower blooms from April 26 to June 13. On May 24 and 28 and June 2 and 5, the following list was observed: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s., one; (2) Ceratina tejonensis Cr. ♂, s., freq.; (3) C. dupla Say ♂♀, s. and c. p., ab.; (4) Alcidamea producta Cr. ♂, s.; (5) Heriades carinatum Cr. ♂, s.; (6) Stelis lateralis Cr. ♂♀, s., freq.; (7) Nomada annulata Sm. ♂♀, s., ab.; *Andrenidae:* (8) Halictus pectoralis Sm. ♀, s.; (9) H. coriaceus Sm. ♀, s. and c. p.; (10) H. ligatus Say ♀, s. and c. p., ab.; (11) H. fasciatus Nyl. ♀, s. and c. p., freq.; (12) H. pilosus Sm. ♀, s. and c. p.; (13) H. confusus Sm. ♀, s. and c. p., freq.; (14) H. albipennis Rob. ♀, s.; (15) Augochlora pura Say ♀, s.; (16) A. similis Rob. ♀, s. and c. p.; (17) Sphecodes mandibularis Cr. ♀, s.; (18) Prosopis pygmaea Cr. ♂, s.; *Eumenidae:* (19 and 20) Odynerus spp., freq.; (21) O. foraminatus Sauss.; (22) O. anormis Say, ab.; *Sphecidae:* (23) Ammophila vulgaris Cr. — all s.

Diptera — *Conopidae:* (24) Zodion fulvifrons Say, s., freq.; (25) Oncomyia loraria Lw., s.; *Syrphidae:* (26) Paragus bicolor F.; (27) P. tibialis Fll.; (28) Mesograpta marginata Say; (29) Sphaerophoria cylindrica Say; *Tachinidae:* (30) sp.; (31) Hyalomyia purpurascens Twns.; (32) Cistogaster occidua Wlk., ab.; (33) C. immaculata Mcq.; (34) Siphophyto sp.; (35) Leucostoma atra Twns.; *Sarcophagidae:* (36–38) Sarcophaga spp.; *Muscidae:* (39) Lucilia cornicina F.; *Anthomyidae:* (40) Anthomyia albicincta Fll.; (41) Chortophila sp. — all s. or f. p.

Coleoptera — *Lampyridae:* (42) Telephorus flavipes Lec.; *Scarabaeidae:* (43) Trichius piger F., ab.; *Chrysomelidae:* (44) Diabrotica 12-punctata Oliv. all f. p.

Lepidoptera — *Rhopalocera:* (45) Phyciodes tharos Dru.; (46) Chrysophanus thoe B.—L.; (47) Ancyloxypha numitor F.; (48) Pamphila peckius Kby.; (49) P. cernes B.—L.; *Heterocera:* (50) Scepsis fulvicollis Hbn. — all s.

Hemiptera — *Capsidae:* (51) Calocoris rapidus Say; (52) Lygus pratensis L.; *Berytidae:* (53) Corizus lateralis Say — all s.

ERIGERON STRIGOSUS Muhl.—This plant resembles *E. philadelphicus*, but is taller, blossoms later, and has white rays which are less numerous and broader. The corolla tubes are shorter, about two millimetres in length.

The insect visitors, as might be expected, closely resemble those of the species just mentioned.

I have noted this plant in bloom from May 17 to September 15. On May 31 and June 8, 12 and 14, I observed the following visitors:—

Hymenoptera—*Apidae:* (1) Apis mellifica L. ♀, s.; (2) Ceratina tejonensis Cr. ♂, s.; (3) C. dupla Say ♂♀, s. and c. p., freq.; (4) Heriades carinatum Cr. ♂♀, s.; (5) Nomada annulata Cr. ♀, s.; *Andrenidae:* (6) Halictus pectoralis Sm. ♀, s. and c. p.; (7) H. ligatus Say ♀, s. and c. p., freq.; (8) H. fasciatus Nyl. ♀, s. and c. p., freq.; (9) H. confusus Sm. ♀, s. and c. p., freq.; (10) H. albipennis Rob. ♀, s. and c. p., freq.; (11) H. pruinosus Rob. ♀, s. and c. p.; (12) H. tegularis Rob. ♀, s. and c. p.; (13) Augochlora similis Rob. ♀, s. and c. p.; (14) Prosopis affinis Sm. ♀, s.; (15) P. pygmaea Cr. ♀, s.; *Eumenidae:* (16-18) Odynerus spp., s., freq.; (19) O. anormis Say, s., freq.; *Philanthidae:* (20) Cerceris clypeata Dahlb., s.; *Sphecidae:* (21) Ammophila pictipennis Walsh, s.; *Chrysididae:* (22) Chrysis sp., s.; *Chalcididae:* (23) Leucospis affinis Say, s.; *Braconidae:* (24) Bracon longicaudus Prov., s.

Diptera—*Empidae:* (25) Empis sp., s.; *Conopidae:* (26) Zodion fulvifrons Say, s.; *Syrphidae:* (27) Paragus bicolor F.; (28) P. tibialis Fll.; (29) Mesograpta geminata Say; (30) M. marginata Say, freq.; (31) Sphaerophoria cylindrica Say; (32) Eristalis dimidiatus Wd.; (33) Tropidia mamillata Lw.; (34) Syritta pipiens L.; *Tachinidae:* (35) sp. (36) Hyalomyia purpurascens Twns.; (37) Gymnosoma fuliginosa R. D.; (38) Cistogaster occidua Wlk.; (39) C. immaculata Mcq.; (40) Ocyptera euchenor Wlk.; (41) Miltogramma cinerascens Twns.; (42) M. argentifrons Twns.; (43) M. flavicornis Twns., freq.; (44) Sarcomacronychia aurifrons Twns.; (45) Leucostoma atra Twns.; *Sarcophagidae:* (46 and 47) Sarcophaga spp.; *Muscidae:* (48) Lucilia cornicina F.; *Anthomyidae:* (49) Anthomyia albicincta Fll.; (50) Limnophora sp.; (51) Chortophila sp.; *Muscidae acalyptratae:* (52) sp.—all s. or f. p.

Coleoptera—*Malachidae:* (53) Collops 4-maculatus F.; *Mordellidae:* (54) Mordellistena comata Lec., freq.—both f. p.

Lepidoptera—*Lycaenidae:* (55) Chrysophanus thoe B.—L., s.

Hemiptera—*Capsidae:* (56) Lygus pratensis L., s.

ANTENNARIA PLANTAGINIFOLIA Hook.—This is the earliest of the indigenous Compositae, blooming from April 12 to May 6. On ten days—April 14 to May 4—the following visitors were observed:—

Hymenoptera—*Apidae:* (1) Bombus americanorum F. ♀, s., one; (2) Ceratina tejonensis Cr. ♂.; (3) C. dupla Say ♂, s., ab.; (4) Nomada maculata Cr. ♂; (5) N. luteola Lep. ♀; *Andrenidae:* (6) Panurgus? andrenoides Cr. ♀, s.; (7) Andrena sayi Rob. ♀, s.; (8) A. claytoniae Rob. ♂, s. (9) Augochlora pura Say ♀, s. and c. p., freq.; (10) A. similis Rob. ♀, s. and c. p.; (11) Halictus lerouxii Lep. ♀, s.; (12) H. ligatus Say ♀, s. and c. p.

ab.; (13) H. fasciatus Nyl. ♀, s. and c. p., ab.; (14) H. confusus Sm. ♀, s. and c. p., ab.; (15) H. stultus Cr. ♀, s. and c. p., ab.; (16) Sphecodes antennariae Rob. ♀, s.

Diptera — *Empidae:* (17) Empis sp., s.; *Syrphidae:* (18) Chrysogaster nitida Wd.; (19) Platychirus quadratus Say; (20) P. hyperboreus Staeg.; (21) Mesograpta geminata Say; (22) M. marginata Say; (23) Sphaerophoria cylindrica Say; (24) Eristalis aeneus F.— all s. and f. p.; *Tachinidae:* (25) Gonia frontosa Say, s., ab.; (26) Phorocera edwardsii Will.; *Sarcophagidae:* (27) Sarcophaga sp.; (28) Cynomyia sp.; *Muscidae:* (29) Cyrtoneura sp.; (30) Lucilia cornicina F.; *Anthomyidae:* (31) Limnophora sp.; (32 and 33) Chortophila spp. *Oscinidae:* (34) Chlorops sp.— all s. or f. p.

Lepidoptera — *Rhopalocera:* (35) Pyrameis huntera F.; (36) Nisoniades brizo B.— L.; *Heterocera:* (37) Drasteria erechtea Cram.

Coleoptera — *Oedemeridae:* (38) Asclera ruficollis Say, f. p.

Silphium integrifolium Michx.— The plant is common on prairies, grows from one to two metres high, and bears yellow heads which expand about four or five centimetres.

The ray-flowers are female; those of the disc, male. The disc-flowers have a long, undivided hairy style which serves to expose the pollen to the visitors. Nectar is secreted by the disc flowers, which have tubes six or seven millimetres long. This places the nectar beyond the reach of short-tongued insects.

The flowers bloom from July 9 to September 7. The visitors were observed on July 13, 14, 19, 28, and August 9: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s., one; (2) Melissodes dentiventris Sm. ♂, s., freq.; (3) M. aurigenia Cr. ♂, s., freq.; (4) M. obliqua Say ♂, s.; (5) Ceratina dupla Say ♀, s., freq.; (6) Megachile pugnata Say ♂♀, s. and c. p., ab.; (7) M. inimica Cr. ♂, s.; (= M. sayi Cr.); (8) M. montivaga Cr. ♂, s.; (9) M. petulans Cr. ♂, s., freq.; (10) M. brevis Say ♂, s.; (11) Epeolus remigatus F. ♂, s.; (12) E. lunatus Say ♂, s.; *Andrenidae:* (13) Halictus ligatus Say ♀, s.; (14) Agapostemon viridula F. ♂♀, s. and c. p.

Diptera — *Bombylidae:* (15) Systoechus vulgaris Lw., s.; *Tachinidae:* (16) Cistogaster occidua Wlk., s.

Silphium laciniatum L.— Visitors — July 16, 18, 20, 25, and August 4:—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s.; (2) Bombus separatus Cr. ☿♀, s., (3) B. americanorum F. ☿, s.; (4) Melissodes aurigenia Cr. ♂♀, s., ab.; (5) M. coloradensis Cr. ♂, s.; (6) M. bimaculata Lep. ♂, s.; (7) Ceratina dupla Say ♀, s.; (8) Megachile brevis Say ♀, s.; (9) M. pugnata Say ♀, s. and c. p.; (10) Epeolus remigatus F. ♂, s.; *Andrenidae:*

(11) Agapostemon texanus Cr. ♀, s.; (12) A. viridula F. ♀, s. and c. p.; (13) Halictus ligatus Say ♀, c. p.; (14) H. pilosus Sm. ♀, c. p.; (15) H. stultus Cr. ♀, c. p.

Diptera — *Conopidae:* (16) Zodion leucostoma Will.; (17) Z. fulvifrons Say; *Syrphidae:* (18) Allograpta obliqua Say; (19) Eristalis latifrons Lw.: (20) E. transversus Wd.— all s.

Lepidoptera — *Rhopalocera:* (21) Danais archippus F.; (22) Colias philodice Gdt., freq. —both s.

PARTHENIUM INTEGRIFOLIUM L.— The stems grow from seven to ten decimetres high, and bear dense flat-topped corymbs of heads which measure about eight millimetres across.

Each head contains five fertile flowers with broad and short obcordate ligules. Each fertile flower thus has a cup-like form. The disc flowers are numerous and sterile. The pistillate flowers are white. The lobes of the staminate flowers and the chaff are terminated by white club-shaped hairs which make the heads looks somewhat woolly and very white.

The flat corymbs form a very conspicuous and convenient landing place. The shallow ray-flowers furnish nectar, and the disc-flowers afford abundant pollen. Numerous small and short-tongued visitors are the result.

I have found the Parthenium in bloom from June 6 to July 30. On the 21st and 27th of June and the 11th of July I noted as visitors:—

Hymenoptera — *Apidae* (1) Ceratina dupla Say ♀, s. and c. p.; (2) Megachile montivaga Cr. ♀, c. p.; (3) Heriades carinatum Cr. ♂♀, s. and c. p.; *Andrenidae:* (4) Halictus ligatus Say ♀, s.; (5) H. fasciatus Nyl. ♀, s. and c. p.; (6) H. pilosus Sm. ♀, s. and c. p.; (7) H. confusus Sm. ♂♀, s. and c. p., ab.; (8) Augochlora similis Rob. ♀, s. and c. p., freq.; (9) A humeralis Pttn. ♀, s.; (10) Prosopis pygmaea Cr. ♂, s.; *Eumenidae:* (11–13) Odynerus spp., freq.; (14) O. anormis Say; *Crabronidae:* (15) Crabro interruptus Lep.; (16) Oxybelus frontalis Rob., freq.; (17) O. emarginatus Say; *Philanthidae:* (18) Cerceris robertsonii Fox; (19) C. compacta Cr.; *Sphecidae:* (20) Ammophila intercepta Lep.; *Scoliidae:* (21) Myzine sexcincta F.; *Chrysididae:* (22) Hedychrum violaceum Brullé v. parvum Aaron; *Braconidae:* (23) Bracon sp.; (24) Agathis vulgaris Cr.; *Tenthredinidae:* (25) Hylotoma humeralis Bv. — all s.

Diptera — *Empidae* (26) Empis sp., s.; *Conopidae:* (27) Zodion fulvifrons Say, s.; *Syrphidae:* (28) Mesograpta marginata Say; (29) M. geminata Say, (30) Sphaerophoria cylindrica Say; (31) Syritta pipiens L.; *Tachinidae:* (32) sp.; (33) Hyalomyia purpurascens Twns.; (34) Cistogaster occidua Wlk.; (35) Ocyptera euchenor Wlk.; (36) Miltogramma cinerascens Twns., freq.; (37) M. argentifrons Twns.; (38) M. flavicornis Twns.:

Sarcophagidae: (39) sp.; (40 and 41) Sarcophaga spp.; *Muscidae:* (42) Stomoxys calcitrans L.; (43) Lucilia cornicina F.; (44) L. sylvarum Mg.; *Anthomyidae:* (45) Anthomyia sp.; (46) A. albicincta Fll.; *Muscidae acalyptratae:* (47) sp.—all s. or f. p.

Coleoptera — *Scarabaeidae:* (48) Trichius piger F., s. and f. p., freq.; *Cerambycidae:* (49) Typocerus sinuatus Newm., f. p., freq.; *Chrysomelidae:* (50) Diabrotica 12-punctata Oliv., f. p.; (51) D. atripennis Say, s.; *Mordellidae:* (52) Pentaria trifasciata Melsh., s.; *Rhipiphoridae:* (53) Rhipiphorus limbatus F., s.

Hemiptera — *Capsidae:* (54) Lygus pratensis L., freq.; (55) Calocorus rapidus Say; *Corimelaenidae:* (56) Corimelaena pulicaria Germ.—all s.

Echinacea angustifolia * DC. — This purple Cone-flower is one of the handsomest of native plants. It grows on prairies. The stems grow from five to ten decimetres high and bear large conical heads with long drooping rays, which are rose-red. The rays are sterile, the disc flowers being hermaphrodite. The corollas measure five millimetres in length, their rigid lobes being erect and rather closely approximated. The nectar is, therefore, deeply seated and closely concealed. The pollen is carried upwards and exposed on the hairy styles. In most of the Compositae the pollen may be gathered with great facility by bees which run about over the heads. In *Echinacea*, however, each pair of pollen-laden styles is guarded by the stiff tip of a bract, so that it is fairly impossible for any except the smallest bees to collect the pollen, and these cannot do it easily. I have seen the female of *Melissodes obliqua* trying in vain to collect pollen of *E. purpurea*.

The stiff bracts also serve to render the nectar less accessible. On account of the deep-seated nectar, the narrow passage to it, the stiff bracts, excluding bees, and the bright color I am inclined to regard the flowers of *Echinacea* as specially adapted to butterflies, and these, as far as I have observed, are the principal guests.

Echinacea angustifolia, as far as observed, blooms from June 3rd to 30th. June 14, 20 and 21 I noted as visitors: —

Lepidoptera — *Rhopalocera:* (1) Danais archippus F.; (2) Chrysophanus

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* The plant is figured in Goodale and Sprague "Wild Flowers of America," Plate XXV.

thoe B.— L.; (3) Colias philodice Gdt.; (4) Pamphila peckius Kby.; (5) P. cernes B.— L.— all s.

Hymenoptera — *Apidae:* (6) Ceratina dupla Say ♀, s. and c. p.; (7) Megachile montivaga Cr. ♂, s.; *Andrenidae:* (8) Agapostemon viridula F. ♀.

Coleoptera —*Cerambycidae:* (9) Typocerus sinuatus Newm., f. p.

ECHINACEA PURPUREA Moench.— The stems are taller and more branched than in *E. angustifolia* and, accordingly, the heads are more numerous. The rays are rose-purple, and more expanded than in *E. angustifolia.* The discs appear yellow from the color of the tips of the bracts. The tubes of the disc-florets are narrow and measure about five millimetres long. The rigid tips of the chaff surpass the corollas for three or four millimetres and are so closely crowded that insects cannot reach the nectar unless they are provided with a proboscis eight or nine millimetres long. Pollen is carried out on the hairy tips of the styles but is so closely guarded by the chaff-tips that pollen-collecting bees are unable to remove it.

As in the case of the preceding, the flower seems to be adapted to butterflies, which are the principal visitors.

The plant blooms from June 18 to September 14. August 8 and 24, and September 14 the following visitors were noted: —

Lepidoptera — *Rhopalocera:* (1) Danias archippus F.; (2) Phyciodes nycteis D. — H.; (3) Pieris rapae L.; (4) Colias philodice Gdt.; (5) Papilio troilus L.— all s.

Hymenoptera — *Apidae:* (6) Apis mellifica L. ☿, s., one; (7) Bombus separatus Cr. ♂, s.; (8) Melissodes obliqua Say ♀,s., and trying in vain to collect pollen; *Andrenidae:* (9) Agapostemon viridula F. ♂♀, s. and c. p.

Diptera — *Bombylidae:* (10) Exoprosopa decora Lw.; (11) Systoechus vulgaris Lw.— both s.

RUDBECKIA HIRTA L.— The stems grow from three to six decimetres high and bear conspicuous heads with bright yellow rays.

The ray-flowers are neutral. The flowers of the disc are hermaphrodite. The pollen is carried out on the hairy tips of the approximated style-divisions.

The tubes are slender and measure about four millimetres in length. The nectar, therefore, is accessible only to the longer and more slender tongues, but the pollen is easily accessible.

This plant holds an important place in the economy of *Calliopsis albitarsis* and *Andrena rudbeckiae.*

It blooms from June 1st to September 16th, though the last of July ends its maximum blooming period.

The list of visitors is the result of observations made on thirteen days, between June 9 and August 22 :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s.; (2) Melissodes perplexa Cr. ♀, s. and c. p., freq.; (3) M. dentiventris Sm. ♀, s.; (4) M. obliqua Say ♂, s.; (5) Ceratina dupla Say ♀, s. and c. p.; (6) Megachile addenda Cr. ♀, s.; (7) M. pugnata Say ♀, c. p.; (8) M. montivaga Cr. ♀, c p.; (9) M. brevis Say ♂♀, s.; (10) Coelioxys altilis Cr. ♂, s.; (11) Epeolus lunatus Say ♂, s.; (12) Nomada annulata Sm. ♂♀, s.; (13) Calliopsis albitarsis Cr. ♂♀, s. and c. p., ab.; (14) C. illinoensis Cr. ♂♀, s. and c. p., ab.; *Andrenidae:* (15) Andrena rudbeckiae Rob. ♂♀, s. and c. p., ab.; (16) Agapostemon viridula F. ♀, s. and c. p.; (17) Augochlora pura Say ♀, s. and c. p.; (18) Halictus sp. ♀, c. p.; (19) H. pectoralis Sm. ♂♀, s. and c. p., freq.; (20) H. ligatus Say ♀, s. and c. p.; (21) H. pilosus Sm. ♂♀, s. and c. p.; (22) H. pruinosus Rob. ♂, s.; (23) H. confusus Sm. ♂♀, s. and c. p.; *Eumenidae:* (24) Odynerus arvensis Sauss.; (25) O. anormis Say; *Bembecidae:* (26) Monedula pictifrons Sm.; *Sphecidae:* (27) Ammophila intercepta Lep., freq.; (28) A. pictipennis Walsh; (29) Prionony x thomae F. — all s.

Diptera — *Stratiomyidae:* (30) Odontomyia nigrirostris Lw., s.; *Bombylidae:* (31) Exoprosopa decora Lw.; (32) E. fascipennis Say; (33) Anthrax parvicornis Lw.; (34) Sparnopolius fulvus Wd. — all four s.; *Conopidae.* (35) Zodion fulvifrons Say,s.; *Syrphidae:* (36) Paragus tibialis Fll.; (37) Allograpta obliqua Say; (38) Mesograpta marginata Say, ab.; (39) Sphaerophoria cylindrica Say; (40) Eristalis dimidiatus Wd.; (41) E. latifrons Lw., ab.; (42) E. transversus Wd., ab.; (43) E. aeneus F.; (44) Helophilus latifrons Lw.; (45) Tropidia mamillata Lw.; (46) Syritta pipiens L.; *Tachinidae:* (47) Ocyptera euchenor Wlk., freq.; (48) Jurinia apicifera Wlk.; (49) Cuphocera ruficauda v. d. W.; (50) Acroglossa hesperidarum Will., freq.; *Anthomyidae:* (51) sp.; (52) Coenosia sp. — all s. or f. p,

Lepidoptera — *Rhopalocera:* (53) Argynnis cybele F.; (54) Phyciodes nycteis D.— H.; (55) P. tharos Dru.; (56) Liminitis disippus Gdt.; (57) Thecla calanus Hbn.; (58) Chrysophanus thoe B.— L.; (59) Pieris rapae L.; (60) Colias philodice Gdt.; (61) Pamphila peckius Kby.; (62) P. cernes B. — L.; *Heterocera:* (63) Scepsis fulvicollis Hbn.; (64) Plusia simplex Gn.— all s.

Coleoptera — *Buprestidae:* (65) Acmaeodera pulchella Hbst.; *Cerambycidae:* (66) Typocerus sinuatus Newm., freq.; *Chrysomelidae:* (67) Diabrotica atripennis Say; *Mordellidae:* (68) Mordella scutellaris F.; *Meloidae:* (69) Macrobasis unicolor Kby.; *Curculionidae:* (70) Centrinus scutellum-album Say — all f. p.

Rudbeckia triloba L.— The stems grow from six to fifteen decimetres high and bear numerous small heads with black-purple centers and yellow rays. The heads expand

four or five centimetres. The tubes of the disc-florets are very narrow and measure about three millimetres in length.

This species blooms from July 23 to October 16. The following list, which contains an interesting assemblage of long-tongued flies, was observed on eight days, between August 4 and September 14 :—

Hymenoptera — *Apidae:* (1) Bombus separatus Cr. ♂, s., one; (2) Melissodes obliqua Say ♀, s. and c. p.; (3) M. perplexa Cr. ♀, s. and c. p.; (4) M. confusa Cr. ♂, s.; (5) Epeolus mercatus F. ♂♀, s.; (6) Calliopsis illinoensis Cr. ♂♀, s. and c. p., ab.; (7) C. labrosus Rob. (MS) ♂♀, s. and c. p.; (8) C. compositarum Rob. ♂, s.; (9) C. asteris Rob. (MS) ♀, s. and c. p.; *Andrenidae:* (10) Andrena aliciae Rob. ♂♀, s. and c. p., freq.; (11) Halictus pectoralis Sm. ♀, s. and c. p., freq.; (12) H. coriaceus Sm. ♀, s.; (13) H. ligatus Say ♀, s.; (14) H. fasciatus Nyl. ♀, s.; (15) Colletes compacta Cr. ♀, s. and c. p.; (16) C. americana Cr. ♀, s. and c. p.; *Vespidae:* (17) Polistes pallipes Lep., s.; *Eumenidae:* (18) Odynerus arvensis Sauss., s.; *Sphecidae:* (19) Ammophila gracilis Lep., s.; *Scoliidae:* (20) Scolia bicincta F., s.; *Ichneumonidae:* (21) Exetastes suaveolens Walsh, s.

Diptera — *Empidae:* (22) Empis sp.; *Syrphidae:* (23) Eristalis transversus Wd.; *Bombylidae:* (24) Exoprosopa decora Lw.; (25) E. fascipennis Say; (26) Anthrax halcyon Say, freq.; (27) Sparnopolius fulvus Wd.; (28) Systropus macer F.; (29) Toxophora amphitea Wlk.; (30) Lepidophora aegeriiformis Westwood; *Tachinidae:* (31) Cuphocera ruficauda v. d. W.; (32) Epigrimyia polita Twns.; (33) Coronimyia geniculata Twns., ab.; (34) Siphoplagia anomala Twns.; *Dexidae:* (35) sp.; (36) Prosena sp., freq. — all s.

Lepidoptera — *Nymphalidae:* (37) Phyciodes tharos Dru.; (38) P. nycteis D.—H.; *Papilionidae:* (39) Pieris protodice B.—L.; (40) Colias philodice Gdt.— all s.

Coleoptera — *Mordellidae:* (41) Mordellistena sp.

Lepachys pinnata Torr. and Gray. — The plant grows about one metre high. The stem and branches bear single heads with conspicuous, drooping yellow rays. The ray-florets are neutral. The disc is oblong. The tubes of the disc-florets are two millimetres in length. The florets and the chaff, with its thickened tips, form a very compact mass which renders it easy for *Melissodes obliqua* to run around the heads and clean up the pollen in her copious scopae. This bee, though by no means the exclusive visitor, is by far the most abundant, being more common on this than any other flower. This *Melissodes* is the most important pollinator of *Lepachys pinnata*, and the plant in turn is the most important in the economy of the bee, being its chief source of pollen supply.

Lepachys pinnata blooms from July 4th to August 29. The list was observed on fifteen days between July 11th and August 9th:—

Hymenoptera — *Apidae:* (1) Melissodes sp. ♂♀, s. and c. p.; (2) M. dentiventris Sm. ♂, s.; (3) M. bimaculata Lep. ♂, s., ab.; (4) M. obliqua Say ♂♀, s. and c. p., very ab.; (5) M. aurigenia Cr. ♂♀, s., freq.; (6) M. perplexa Cr. ♂, s.; (7) Megachile latimanus Say ♂♀, s.; (8) M. pugnata Say ♀, s.; (9) M. inimica Cr. ♂♀, s., ab.; (10) M. addenda Cr. ♀, s.; (11) M. mendica Cr. ♀, s.; (12) M. brevis Say ♂, s.; (13) Alcidamea producta Cr. ♀, s.; (14) Coelioxys totoneca Cr. ♂, s.; (15) Epeolus remigatus F. ♂♀, s., ab.; (16) E. lunatus Say ♂♀, s., ab.; (17) E. mercatus F. ♀, s.; (18) E. fumipennis Say ♂, s.; *Andrenidae:* (19) Halictus lerouxii Lep. ♀, s. and c. p.; (20) H. ligatus Say ♂♀, s. and c. p., ab., (21) H. albipennis Rob. ♀, s. and c. p.; (22) Agapostemon radiatus Say ♂, s.; (23) Augochlora humeralis Pttn. ♂, s.; *Eumenidae:* (24) Odynerus sp.; (25) O. arvensis Sauss.; (26) O. anormis Say; *Bembecidae:* (27) Bembex nubillipennis Cr., ab.; (28) Monedula pictifrons Sm., freq.; *Sphecidae:* (29) Ammophila intercepta Lep.; (30) A. pictipennis Walsh; (31) Prionony x atrata Lep.; (32) P. thomae F. — all s.

Lepidoptera — *Rhopalocera:* (33) Phyciodes tharos Dru.; (34) Thecla humuli Harr.; (35) Lycaena comyntas Gdt.— all s.

Diptera — *Empidae*: (36) Empis sp.; *Bombylidae:* (37) Geron senilis F.; *Conopidae:* (38) Zodion leucostoma Will., freq.; *Muscidae acalyptratae:* (39) sp.— all s.

Coleoptera — *Buprestidae:* (40) Acmaeodera pulchella Hbst.; *Cerambycidae:* (41) Typocerus sinuatus Newm.— both f. p.

HELIANTHUS MOLLIS Lam.— The stems grow from six to ten decimetres high and bear rather large heads with yellow discs. The heads commonly look towards the east. They expand five or six centimetres or more. The disc-florets have tubes about six millimetres long.

Helianthus mollis blooms from July 21 to September 7, and on August 17 and 19, was found to be visited by:—

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♂♀, s., freq.; (2) Melissodes obliqua Say ♂♀, s. and c. p., freq.; (3) M. coloradensis Cr. ♂, s.; (4) Epeolus remigatus F. ♀, s., freq.; *Andrenidae:* (5) Agapostemon viridula F. ♂, s.

Diptera — *Bombylidae:* (6) Anthrax halcyon Say; (7) Systoechus vulgaris Lw., freq.; *Tachinidae:* (8) Siphoplagia anomala Twns. — all s.

Lepidoptera — *Papilionidae:* (9) Colias philodice Gdt., s.

HELIANTHUS GROSSE-SERRATUS Martens. — Visitors — observed on 16 days, between September 1 and October 4: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s., ab.; (2) Bombus separatus Cr. ♂♀, s.; (3) B. scutellaris Cr. ♀, s.; (4) B. pennsylvanicus

De G. ♀, s.; (5) B. americanorum F. ♂♀, s., ab.; (6) B. virginicus Oliv. ♀ ♀, s.; (7) Melissodes sp. ♀, s.; (8) M. coloradensis Cr. ♀, s. and c. p.; (9) M. obliqua Say ♀, s. and c. p., freq.; (10) M. perplexa Cr. ♀, s. and c. p., freq.; (11) M. dentiventris Sm. ♀, s. and c. p., freq.; (12) M. aurigenia Cr. ♂♀, s. and c. p., ab.; (13) M. desponsa Sm. ♀, s. and c. p.; (14) Megachile latimanus Say ♂♀, s. and c. p., ab.; (15) M. inimica Cr. ♀, s.; (16) M. brevis Say ♀, s. and c. p.; (17) M. optiva Cr. ♀, s.; (18) Coelioxys dubitata Sm. ♀, s.; (19) Epeolus remigatus F. ♀, s.; (20) E. mercatus F. ♀, s., freq.; (21) Nomada vincta Say ♂♀, s., freq.; (22) Calliopsis illinoensis Cr. ♀, s. and c. p.; (23) C. solidaginis Rob. ♀, s.; (24) Panurgus autumnalis Rob. (MS) ♀, s. and c. p., freq.; (25) Andrena helianthi Rob. ♂♀, s. and c. p., ab.; (26) A. pulchella Rob. ♀, s. and c. p., ab.; (27) Halictus ligatus Say ♀, s. and c. p.; (28) Agapostemon viridula F. ♂, s.; *Bembecidae:* (29) Bembex nubillipennis Cr., s.; *Sphecidae:* (30) Prionony x atrata Lep., s.

Diptera — *Bombylidae:* (31) Systoechus vulgaris Lw., freq.; (32) Sparnopolius fulvus Wd., ab.; (33) Exoprosopa decora Lw. — all s.; *Syrphidae:* (34) Syrphus americanus Wd.; (35) Eristalis tenax L.; (36) E. latifrons Lw., ab.; (37) E. transversus Wd.; (38) Helophilus latifrons Lw. — all s. and f. p.; *Tachinidae:* (39) sp., s.; *Muscidae:* (40) Lucilia cornicina F., s.; *Anthomyidae:* (41) sp., s.

Lepidoptera — *Rhopalocera:* (42) Danais archippus F., freq.; (43) Euptoieta claudia Cram.; (44) Argynnis cybele F.; (45) Pyrameis cardui L., freq.; (46) P. huntera F.; (47) Papilio philenor L.; (48) Meganostoma caesonia Stoll; (49) Colias philodice Gdt.; (50) Pyrgus tessellata Scud.; *Heterocera:* (51) Scepsis fulvicollis Hbn.; (52) Utetheisa bella L.; (53) Plusia simplex Gn. — all s.

Coleoptera — *Lampyridae:* (54) Chauliognathus pennsylvánicus De G.; *Chrysomelidae:* (55) Diabrotica longicornis Say; (56) D. 12-punctata Oliv. — all f. p.

HELIANTHUS STRUMOSUS L.— The heads expand five or six centimetres. The disc corollas measure six millimetres in length.

This Helianthus blooms from July 21 to September 3. The following visitors were taken on the flowers on August 22 and 24:—

Hymenoptera — *Apidae:* (1) Bombus separatus Cr. ♂, s.; (2) Melissodes obliqua Say ♂♀, s. and c. p., freq.; (3) Ceratina dupla Say ♀, s.; (4) Megachile petulans Cr. ♂, s.; (5) Epeolus remigatus F. ♀, s.; (6) E. mercatus F. ♂, s.; (7) Calliopsis labrosus Rob. (MS) ♀, s.; *Andrenidae:* (8) Andrena pulchella Rob. ♀, s., freq.; *Sphecidae:* (9) Ammophila intercepta Lep., s.

Diptera — *Bombylidae:* (10) Anthrax halcyon Say, s.; (11) Systoechus vulgaris Lw.; (12) Sparnopolius fulvus Wd.— all s.

Lepidoptera — *Rhopalocera:* (13) Phyciodes nycteis D.— H.; (14) Colias philodice Gdt.— both s.

HELIANTHUS TUBEROSUS L.— The stems grow two or three metres high and bear conspicuous yellow heads which expand from six to eight centimetres. The disc florets have corollas with tubes six milimetres long.

On fifteen days during the blooming time — August 13 to 26 — I observed the following visitors: —

Hymenoptera — *Apidae:* (1) Bombus vagans Sm. ♂, s.; (2) B. americanorum F. ♂☿, s. and c. p., freq.; (3) B. separatus Cr. ♂♀, s.; (4) Melissodes dentiventris Sm. ♂♀, s.; (5) M. obliqua Say ♀, s. and c. p., ab.; (6) M. coloradensis Cr. ♂♀, s. and c. p., freq.; (7) M. aurigenia Cr. ♂♀, s. and c. p., freq.; (8) M. confusa Cr. ♂, s.; (9) Megachile inimica Cr. ♀, c. p.; (10) M. brevis Say ♀, s.; (11) Epeolus lunatus Say ♀, s.; (12) E. remigatus F. ♀, s.; (13) Nomada vincta Say ♀, s.; (14) Calliopsis labrosus Rob. (MS) ♂♀, s. and c. p.; (15) C. rugosus Rob. (MS) ♂♀, s. and c. p , ab.; *Andrenidae:* (16) Andrena pulchella Rob. ♂♀, s. and c. p., ab.; (17) A. aliciae Rob. ♀, s. and c. p.; (18) Halictus coriaceus Sm. ♀, s. and c. p.; (19) H. pectinatus Rob. ♀, s. and c. p.; (20) H. ligatus Say ♀, s. and c. p.; *Philanthidae:* (21) Cerceris kennicottii Cr., s.; *Scoliidae:* (22) Scolia bicincta F., s.

Diptera — *Bombylidae:* (23) Exoprosopa fascipennis Say, freq.; (24) E. decora Lw.; (25) Anthrax halcyon Say, freq.; (26) Systoechus vulgaris Lw., freq.; (27) Sparnopolius fulvus Wd., ab. — all s.; *Syrphidae:* (28) Eristalis transversus Wd., s.; (29) E. tenax L., f. p.; *Muscidae:* (30) Lucilia cornicina F., s.; *Trypetidae:* (31) Trypeta finalis Lw.

Lepidoptera — *Rhopalocera:* (32) Phyciodes tharos Dru.; (33) Thecla m-album B. — L.; (34) Colias philodice Gdt.; (35) Pholisora catullus F. — all s.

Coleoptera — *Lampyridae:* (36) Chauliognathus pennsylvanicus De G.; *Chrysomelidae:* (37) Diabrotica longicornis Say; *Mordellidae:* (38) Mordella scutellaris F.; *Meloidae:* (39) Epicauta pennsylvanica De G. — all f. p.

VERBESINA HELIANTHOIDES Michx. — The plants grow from six to twelve decimetres high and have few heads, five or six centimetres wide. The rays are neutral, the disc-florets hermaphrodite.

The corollas are five or six mm. long.

The plant blooms from June 16 to August 10. The visitors were observed on July 5, 6, and 11 :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ☿, s., one; (2) Bombus americanorum F. ☿, s.; (3) Melissodes obliqua Say ♀, s.; (4) Ceratina dupla Say ♀, s.; (5) Megachile pollicaris Say ♂, s.; (6) M. pugnata Say ♂♀, s. and c. p., freq.; (7) M. brevis Say ♂♀, s. and c. p., freq.; (8) M. mendica Cr. ♀ s. and c. p.; (9) M. petulans Cr. ♂, s.; (10) Alcidamea producta Cr. ♀, c. p.; (11) Coelioxys sp. ♂, s.; (12) C. altilis Cr. ♂, s.; (13) Calliopsis albitarsis Cr. ♂, s.; *Andrenidae*; (14) Halictus lerouxii

Lep. ♀, s. and c. p.; (15) H. ligatus Say ♂, s.; (16) Augochlora similis Rob. ♀, s. and c. p.; (17) Agapostemon viridula F. ♀, s.; *Bembecidae:* (18) Monedula pictifrons Sm., s.; *Sphecidae;* (19) Ammophila gryphus Sm., s., freq.; (20) A. intercepta Lep., s., freq.; (21) A. pictipennis Walsh, s.

Diptera — *Bombylidae:* (22) Systoechus vulgaris Lw.; (23) Anthrax parvicornis Lw.; *Syrphidae*: (24) Eristalis transversus Wd. — all s.

Lepidoptera — *Ctenuchidae:* (25) Scepsis fulvicollis Hbn., s.

COREOPSIS PALMATA Nutt. — The plants grow in small, thin patches; the stems rise about six decimetres high and bear conspicuous yellow heads about four centimetres wide. The ray florets are neutral, those of the disc, hermaphrodite.

The corollas are five or six millimetres long, the tube being very narrow below.

I have noted the plant in bloom from June 17 to July 8. The visitors were observed on June 27, 29 and July 1: —

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♀, s.; (2) Melissodes confusa Cr. ♂, s.; (3) Ceratina dupla Say ♀, s., freq.; (4) Megachile brevis Say ♀, s., freq.; (5) Nomada annulata Sm. ♀, s.; (6) Calliopsis albitarsis Cr. ♀, s.; (7) C. andreniformis Sm. ♀, s.; *Andrenidae:* (8) Halictus ligatus Say ♂♀, s. and c. p., freq.; (9) H. fasciatus Nyl. ♀, s.; (10) H. pilosus Sm. ♀, s. and c. p.; (11) Augochlora similis Rob. ♀, s. and c. p.; *Eumenidae:* (12) Odynerus anormis Say; *Sphecidae:* (13) Ammophila gryphus Sm.; (14) A. vulgaris Cr.; (15) A. intercepta Lep.; (16) A. pictipennis Walsh; (17) Prionopyx thomae F.; *Braconidae:* (18) Toxoneura abdominalis Cr. — all s.

Diptera — *Stratiomyidae:* (19) Odontomyia nigrirostris Lw.; *Conopidae:* (20) Zodion fulvifrons Say; *Muscidae:* (21) Stomoxys calcitrans L.; (22) Lucilia sp.; *Muscidae acalyptratae:* (23) sp. — all s.

Lepidoptera — *Rhopalocera:* (24) Phyciodes tharos Dru.; (25) Colias philodice Gdt.; (26) Pamphila cernes B. — L. — all s.

Coleoptera — *Cerambycidae:* (27) Typocerus sinuatus Newm.; *Mordellidae:* (28) Mordella scutellaris F.; *Meloidae:* (29) sp. — all f. p.

COREOPSIS TRIPTERIS L. — The stems grow from fifteen to twenty-five decimetres high and are terminated by corymbose clusters of small heads with yellow rays and dark-purple centers. The rays are neutral. The tubes of the disc florets are about six millimetres long, but a proboscis four millimetres long can obtain some of the nectar. The plants are generally scattered so that they do not attract insects in great numbers.

This species blooms later than the preceding — July 26 to September 26. The visitors were observed August 22, 24 and 30: —

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♀, s.; (2) Melissodes obliqua Say ♀, s. and c. p.; (3) M. dentiventris Sm. ♂, s., freq.; (4) Megachile montivaga Cr. ♀, s.; (5) Epeolus remigatus F. ♀, s.; (6) Calliopsis labrosus Rob. (MS) ♂♀, s.; *Andrenidae:* (7) Andrena pulchella Rob. ♀, s. and c. p.; (8) Halictus pectoralis Sm. ♀, s.; (9) H. ligatus Say ♀, s. and c. p.; *Sphecidae:* (10) Ammophila gryphus Sm., s.; *Scoliidae:* (11) Scolia bicincta F., s., freq.

Diptera — *Bombylidae:* (12) Anthrax halcyon Say; (13) Systoechus vulgaris Lw.; (14) Sparnopolius fulvus Wd.; (15) Lepidophora aegeriiformis Westwood; *Tachinidae:* (16) Coronimyia geniculata Twns. — all s.

Coreopsis aristosa Michx.— Visitors observed on fourteen days — August 2 to September 15 :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s., ab.; (2) Bombus separatus Cr. ♂, s., freq.; (3) B. scutellaris Cr. ♀, s.; (4) B. americanorum F. ♂♀, s. and c. p., ab.; (5) B. virginicus Oliv. ♂♀♀, s. and c. p., ab.; (6) Melissodes bimaculata Lep. ♀, s.; (7) M. desponsa Sm. ♀, s. and c. p.; (8) M. dentiventris Sm. ♂♀, s. and c. p.; (9) M. aurigenia Cr. ♀, s. and c. p., freq.; (10) M. perplexa Cr. ♂♀, s. and c. p., ab.; (11) Ceratina dupla Say ♀, s. and c. p.; (12) Megachile brevis Say ♂♀, s. and c. p., freq.; (13) M. optiva Cr. ♀, s. and c. p.; (14) Heriades carinatum Cr. ♂, s.; (15) Epeolus mercatus F. ♂♀, s., freq.; (16) Calliopsis octomaculatus Rob. (MS) ♂♀, s. and c. p., ab.; (17) C. illinoensis Cr. ♂♀, s. and c. p., ab.; (18) C. rugosus Rob. (MS) ♀, s. and c. p.; (19) C. compositarum Rob. ♂, s.; (20) C. labrosus Rob. (MS) ♂♀, s. and c. p.; *Andrenidae:* (21) Andrena aliciae Rob. ♀, s. and c. p.; (22) Halictus coriaceus Sm. ♂, s.; (23) H. ligatus Say ♀, s.; (24) Agapostemon viridula F. ♂♀, s. and c. p.; (25) A. radiatus Say ♀, s. and c. p.; (26) Augochlora labrosa Say ♀, s.; (27) Colletes spinosa Rob. ♀, s.; (28) C. compacta Cr. ♂♀, s., freq.; *Vespidae:* (29) Vespa germanica F.; *Eumenidae:* (30) Odynerus tigris Sauss.; *Bembecidae:* (31) Bembex nubillipennis Cr.; (32) B. fasciata F.; (33) Bembedula ventralis Say; *Sphecidae:* (34) Ammophila intercepta Lep.; (35) Pelopoeus cementarius Dru.; *Scoliidae:* (36) Myzine sexcincta F.; (37) Scolia bicincta F., ab.; *Braconidae:* (38) sp.; *Ichneumonidae:* (39) Exetastes suaveolens Walsh — all s.

Diptera — *Bombylidae:* (40) Exoprosopa fasciata Mcq.; (41) E. fascipennis Say; (42) E. decora Lw.; (43) Anthrax halcyon Say; (44) Sparnopolius fulvus Wd., ab.; (45) Systropus macer F.; (46) Toxophora amphitea Wlk. — all s.; *Conopidae:* (47) Zodion fulvifrons Say, s.; *Syrphidae;* (48) Chrysogaster nitida Wd.; (49) Syrphus americanus Wd.; (50) Mesograpta polita Say; (51) Eristalis dimidiatus Wd., freq.; (52) E. latifrons Lw.; (53) E. transversus Wd.— all s. or f. p.; *Dexidae:* (54 and 55) spp.; (56) Prosena sp.; (57) Scotiptera parvicornis Twns. — all s.; *Tachinidae:* (58 and 59) spp., s., freq.; (60) Jurinia smaragdina Mcq., freq.; (61) Echinomyia robusta Wd., freq.; (62) Siphoplagia anomala Twns., freq ; (63) Miltogramma argentifrons Twns ; (64) Acroglossa hesperidarum Will.— all s.; *Sarcophagidae:* (65) Sarcophaga sp., s.; *Muscidae:* (66) Lucilia caesar L., s.; (67) Compsomyia macellaria F., s.; *Anthomyidae:* (68) Chortophila sp., s.

Lepidoptera — *Rhopalocera:* (69) Danais archippus F., freq.; (70) Argynnis cybele F.; (71) Phyciodes tharos Dru.; (72) Pyrameis cardui L., freq.; (73) Limenitis disippus Gdt.; (74) L. ursala F.; (75) Papilio philenor L.; (76) P. asterias F.; (77) Pieris rapae L.; (78) Colias philodice Gdt.; (79) Pamphila cernes B. — L.; (80) Nisoniades juvenalis F.; (81) Eudamus tityrus F.; *Heterocera:* (82) Heliothis armiger Hbn. — all s.

Coleoptera — *Lampyridae:* (83) Chauliognathus pennsylvanicus De G., ab., pairing; *Chrysomelidae:* (84) Chrysomela similis Rog.; (85) Diabrotica 12-punctata Oliv.; *Meloidae:* (86) Epicauta cinerea Forst.; (87) E. pennsylvanica De G.; *Rhipiphoridae:* (88) Myodites sp. — all f. p.

Hemiptera — *Pentatomidae:* (89) Euschistus, sp., s.

Bidens chrysanthemoides Michx. — Visitors observed on September 20th :—

Hymenoptera — *Apidae*: (1) Apis mellifica L. ♀, s., ab.; (2) Bombus americanorum F. ♂♀, s., freq.; (3) Melissodes dentiventris Sm. ♀, s.; (4) M. aurigenia Cr. ♀, s. and c. p.; (5) M. perplexa Cr. ♂♀, s. and c. p., freq.; (6) Ceratina dupla Say ♀, s.; (7) Megachile latimanus Say ♀, s. and c. p.; (8) M. brevis Say ♂♀, s. and c. p., freq.; (9) M. mendica Cr. ♂, s.; (10) M. petulans Cr. ♂, s.; (11) Epeolus mercatus F. ♀, s.; *Andrenidae:* (12) Andrena aliciae Rob. ♀; (13) Halictus ligatus Say ♂, s.; (14) H. confusus Sm. ♀, s. and c. p.; (15) Colletes compacta Cr. ♂♀, s. and c. p., freq.; *Vespidae:* (16) Polistes metricus Say, s.; *Eumenidae:* (17) Eumenes fraternus Say, s.; *Scoliidae:* (18) Scolia bicincta F., s., freq.; *Ichneumonidae:* (19) Exetastes suaveolens Walsh, s.

Lepidoptera — *Rhopalocera:* (20) Danais archippus F., ab.; (21) Phyciodes tharos Dru.; (22) Pyrameis huntera F.; (23) P. atalanta L.; (24) Limenitis disippus Gdt.; (25) Chrysophanus thoe B.— L.; (26) Colias philodice Gdt., freq.; (27) Pamphila campestris Bdv. v. huron Edw.; (28) P. phylaeus Dru.; *Heterocera:* (29) Scepsis fulvicollis Hbn.; (30) Feltia subgothica Steph.; (31) Plusia simplex Gn.; (32) Heliothis armiger Hbn.; (33) H. dipsaceus L.—all s.

Diptera — *Bombylidae:* (34) Anthrax halcyon Say, s.; (35) Systoechus vulgaris Lw., s.; (36) Sparnopolius fulvus Wd., s., freq.; *Syrphidae:* (37) Mesograpta marginata Say, s.; (38) Eristalis dimidiatus Wd., s., ab.; (39) E. transversus Wd., s., ab.; (40) Helophilus similis Mcq.; *Tachinidae:* (41) Jurinia smaragdina Mcq., s., freq.; (42) Siphoplagia anomala Twns.; *Muscidae:* (43) Lucilia cornicina F., s., freq.; (44) Compsomyia macellaria F., s., freq.; *Anthomyidae:* (45) Hydrophoria sp.

Coleoptera — *Lampyridae:* (46) Chauliognathus pennsylvanicus De G., s. and f. p., ab.; *Chrysomelidae:* (47) Diabrotica 12-punctata Oliv., f. p.

Helenium autumnale L. — Visitors observed on September 15 and 22 :—

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s. and c. p.; (2) Bombus separatus Cr. ♀, s.; (3) B. scutellaris Cr. ♂, s.; (4) B. americanorum F. ♂♀, s., freq.; (5) B. virginicus Oliv. ♂♀, s., ab.; (6) Melissodes denti-

ventris Sm. ♀, c. p.; (7) M. aurigenia Cr. ♂, s.; (8) M. perplexa Cr. ♀, s. and c. p., ab.; (9) M. confusa Cr. ♀, s. and c. p.; (10) Megachile latimanus Say ♀, s.; (11) M. brevis Say ♀, s. and c. p., ab.; (12) Coelioxys altilis Cr. ♀, s.; (13) Epeolus mercatus F. ♀, s., ab.; *Andrenidae:* (14) Agapostemon viridula F. ♂, s.; (15) Halictus fasciatus Nyl. ♀, s. and c. p.; (16) Colletes compacta Cr. ♀, s. and c. p.; *Vespidae:* (17) Vespa germanica F.; (18) Polistes pallipes Lep.; *Bembecidae:* (19) Bembex fasciata F.; (20) Bembedula ventralis Say, freq.; *Sphecidae:* (21) Ammophila gryphus Sm.; (22) A. intercepta Lep.; (23) Prionony x atrata Lep. — all s.

Lepidoptera — *Rhopalocera:* (24) Phyciodes tharos Dru.; (25) Colias philodice Gdt.; (26) Pamphila cernes B. — L.; *Heterocera:* (27) Scepsis fulvicollis Hbn. — all s.

Diptera — *Bombylidae:* (28) Anthrax halcyon Say; (29) Sparnopolius fulvus Wd.; *Syrphidae:* (30) Syrphus arcuatus Fll. — all s.

Coleoptera — *Lampyridae:* (31) Chauliognathus pennsylvanicus De G., f. p., ab.; *Meloidae:* (32) Epicauta pennsylvanica De G., f. p.

Hemiptera — *Pentatomidae:* (33) Euschistus fisilis Uhl., s.

CNICUS ALTISSIMUS Willd. — Visitors observed on August 22nd and 24th: —

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♂ ♀ ;(2) B. pennsylvanicus De G. ♀ ; (3) Melissodes desponsa Sm. ♂ — all s.

Lepidoptera — *Rhopalocera:* (4) Argynnis cybele F.; (5) Papilio troilus L. — both s.

CNICUS ALTISSIMUS Willd. *v.* DISCOLOR Gray. — The following visitors were observed on September 3, 6, 7 and 15: —

Hymenoptera — *Apidae:* (1) Bombus separatus Cr. ♂, s.; (2) B. scutellaris Cr. ♂ ♀, s. and c. p.; (3) B. pennsylvanicus De G. ♂ ♀ ♀, s. and c. p.; (4) B. americanorum F. ♂ ♀ ♀, s. and c. p., ab.; (5) B. virginicus Oliv. ♀, s. and c. p.; (6) Melissodes desponsa Sm. ♀, s. and c. p., ab.; (7) M. obliqua Say ♀, s. and c. p.; (8) Megachile latimanus Say ♀, s. and c. p., freq.; *Andrenidae*: (9) Colletes eulophi Rob. ♀, c. p., one.

Lepidoptera — *Nymphalidae:* (10) Argynnis idalia Dru., s.

Diptera — *Bombylidae* (11) Exoprosopa fasciata Mcq., s.

CNICUS LANCEOLATUS Hoffm.* — "Nat. from Eu." — Visitors observed on seven days between July 23 and October 7: —

Hymenoptera — *Apidae:* (1) Bombus americanorum F. ♂ ♀ ♀, s. and c. p., ab.; (2) B. virginicus Oliv. ♀, s.; (3) B. pennsylvanicus De G. ♀, s.; (4) B. separatus Cr. ♂ ♀, s., freq.; (5) Melissodes desponsa Sm. ♂ ♀, s. and

* See Müller: Fertilization of Flowers, Weitere Beobachtungen & Alpenblumen.

c. p., ab.; (6) M. obliqua Say ♂♀, s., freq.; (7) M. coloradensis Cr. ♂, s.; (8) M. bimaculata Lep. ♀, s.; (9) M. dentiventris Sm. ♂, s.; (10) M. aurigenia Cr. ♂, s.; (11) Megachile latimanus Say ♀, s. and c. p., freq.; (12) M. sexdentata Rob. (MS) ♂, s.; (13) Epeolus remigatus F. ♀, s.; *Andrenidae:* (14) Halictus ligatus Say ♀, c. p., ab.; (15) H. pilosus Sm. ♀, c. p.; (16) Agapostemon viridula F. ♀, s.; (17) A. radiatus Say ♂, s.

Lepidoptera — *Rhopalocera* (18) Danais archippus F.; (19) Phyciodes tharos Dru.; (20) Pieris protodice B.— L.; (21) Colias philodice Gdt.; (22) Papilio turnus L. and glaucus L.; (23) P. asterias F.; (24) P. troilus L.; (25) Pamphila peckius Kby.; (26) P. cernes B.— L.; (27) Eudamus bathyllus S. and A.; *Heterocera* (28) Scepsis fulvicollis Hbn.— all s.

Diptera — *Bombylidae:* (29) Exoprosopa fasciata Mcq.; (30) Systoechus vulgaris Lw., freq.; *Conopidae:* (31) Physocephala tibialis Say — all s.

KRIGIA AMPLEXICAULIS Nutt. — The plants are often collected in conspicuous patches. The stems grow from three to six decimetres high and bear several yellow heads which expand about three centimetres.

The flowers are all ligulate. The pollen becomes attached to the hairy portion of the style and is thus carried upwards and exposed. The corolla tubes are narrow and measure about two millimetres in length.

The following visitors were observed on May 30th: —

Hymenoptera — *Apidae:* (1) Apis mellifica L. ♀, s. and c. p., one; (2) Synhalonia speciosa Cr. ♂, s.; (3) Ceratina dupla Say ♂♀, s., freq.; (4) Alcidamea producta Cr. ♂, s.; (5) Osmia albiventris Cr. ♀, s.; (6) Nomada annulata Sm. ♂, s., freq.; *Andrenidae:* (7) Halictus ligatus Say ♀, s. and c. p., ab.; (8) H. fasciatus Nyl. ♀, s. and c. p.; (9) H. pilosus Sm. ♀, s. and c. p., freq.; (10) H. albipennis Rob. ♀, s. and c. p., ab.; (11) H. confusus Sm. ♀, s. and c. p., freq.; (12) Augochlora similis Rob. ♀, s. and c. p., ab.; (13) Agapostemon viridula F. ♀, s. and c. p.; (14) Prosopis affinis Sm. ♂, s. and f. p., freq.; (15) P. pygmaea Cr., f. p.; *Eumenidae:* (16–18) Odynerus spp., s., freq. (19) O. foraminatus Sauss., s.; (20) O. anormis Say, s., freq.; *Crabronidae:* (21) Crabro interruptus Lep., s.

Diptera — *Conopidae:* (22) Zodion fulvifrons Say, s.; *Syrphidae:* (23) Mesograpta marginata Say; (24) Sphaerophoria cylindrica Say; (25) Eristalis transversus Wd.; (26) Helophilus similis Mcq.; *Tachinidae:* (27) Cistogaster occidua Wlk.; *Muscidae:* (28) Lucilia cornicina F. — all s. or f. p.

Lepidoptera — *Rhopalocera:* (29) Danais archippus F.; (30) Phyciodes tharos Dru.; (31) Papilio asterias F.; (32) Pamphila peckius Kby. — all s.

Coleoptera — (33) sp.; *Coccinellidae:* (34) Megilla maculata De G.; *Chrysomelidae:* (35) Diabrotica 12-punctata Oliv., freq. — all f. p.

TABLE I.

	Apidae.	Andrena.	Other andrenidae.	Other hymenoptera.	Diptera.	Coleoptera.	Other insects.	Total.	Bees.	Other hymenoptera.	Diptera.	Other insects.
Amelanchier canadensis.....	3	9	6	1	6	..	....	25	18	1	6	...
Prunus americana.....	1	4	5	....	16	1	4	31	10	....	16	5
Geum vernum	..	..	1	....	...	..	....	1	1	....	..	....
Pyrus coronaria.....	6	..	....	....	..	..	2	8	6	....	..	2
Crataegus coccinea v. mollis.....	3	8	8	4	15	4	1	43	19	4	15	5
coccinea.....	5	8	6	3	22	6	2	52	19	3	22	8
Fragaria virginiana v. illinoensis..	3	..	9	....	5	..	....	17	12	....	5	....
Prunus serotina.....	7	9	11	2	21	1	2	53	27	2	21	3
Crataegus crus-galli.....	10	9	13	8	20	3	3	66	32	8	20	6
Rubus villosus.....	4	2	3	....	2	..	....	11	9	....	2	....
occidentalis.....	..	1	....	1	..	..	....	2	1	1	..	....
Potentilla canadensis.....	8	1	8	4	7	..	1	29	17	4	7	1
Rosa humilis.....	6	..	3	....	..	2	....	11	9	....	..	2
setigera	2	..	....	....	..	1	....	3	2	....	..	1
Spiraea aruncus.....	..	4	2	....	3	15	....	24	6	....	3	15
Geum album	2	..	8	6	3	2	1	22	10	6	3	3

TABLE II.

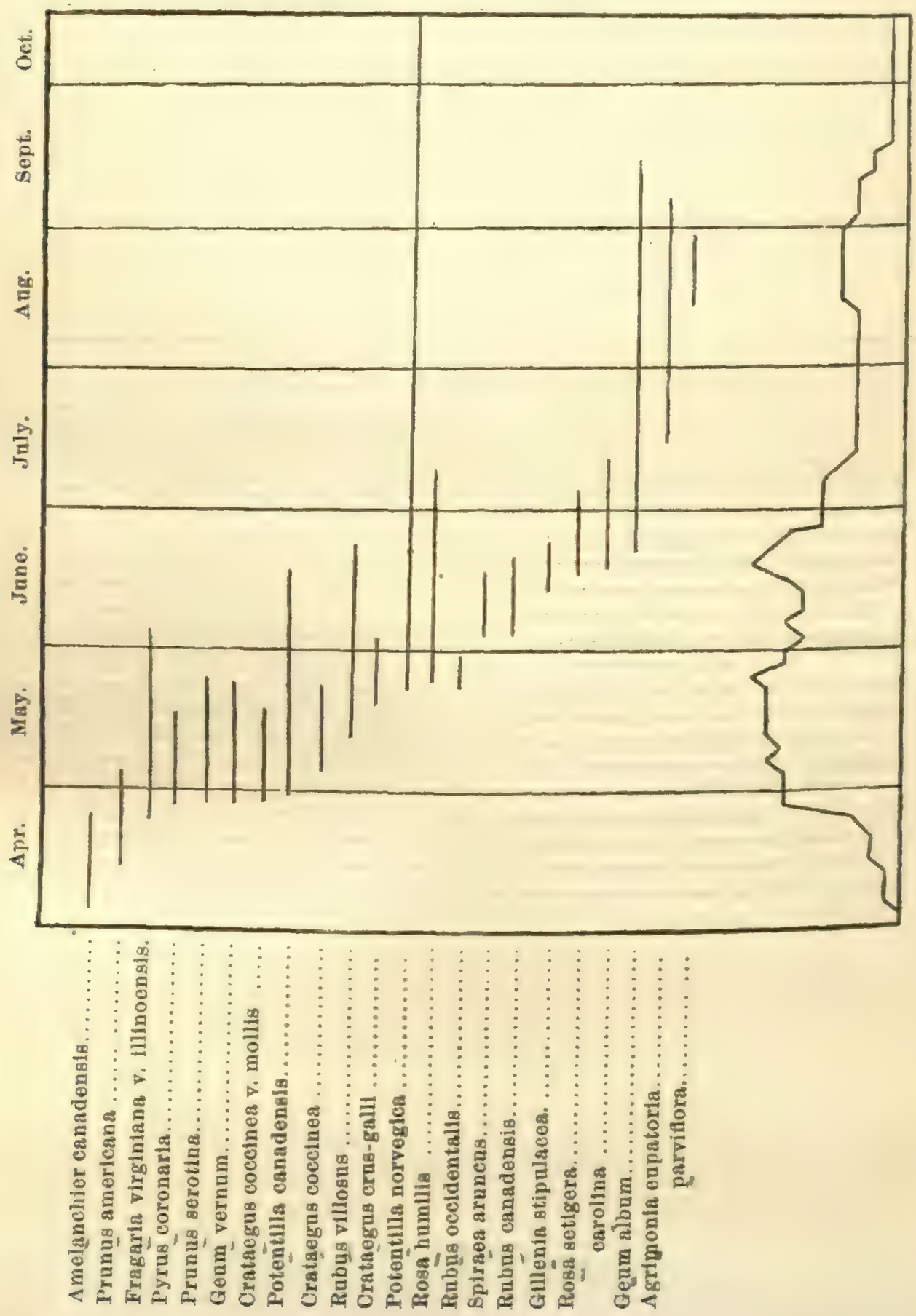
Apr.
May.
June.
July.
Aug.
Sept.
Oct.
Amelanchier canadensis
Prunus americana
Fragaria virginiana v. illinoensis.
Pyrus coronaria
Prunus serotina
Geum vernum
Crataegus coccinea v. mollis
Potentilla canadensis
Crataegus coccinea
Rubus villosus
Crataegus crus-galli
Potentilla norvegica
Rosa humilis
Rubus occidentalis
Spiraea aruncus
Rubus canadensis
Gillenia stipulacea
Rosa setigera
carolina
Geum album
Agrimonia eupatoria
parviflora

TABLE III.

			Bees.	Other hymenoptera.	Diptera.	Coleoptera.	Other insects.	Total.
Prunus	communis	Low Germany.	15	1	10	1	1	28
	padus	"	1	....	2	4	....	7
	domestica, avium, cerasus (mixed list)	"	8	....	3	..	3	14
	avium	"	5	....	..	2	....	7
	armenica	"	5	1	..	..	....	6
	americana	Illinois	10	....	16	1	4	31
	serotina	"	27	2	21	1	2	53
Spiraea	ulmaria	Low Germany.	7	6	10	12	....	35
	"	Alps.	..	....	..	1	....	1
	"	Pyrenees	1	....	..	2	....	3
	filipendula	Low Germany.	2	....	4	4	....	10
	salicifolia, ulmifolia, sorbifolia (mixed)	"	20	15	46	25	4	110
	aruncus	"	4	3	2	6	....	15
	"	Alps.	..	....	..	1	....	1
	"	Illinois	6	....	3	15	....	24
Rubus	fruticosus	Low Germany.	40	8	18	20	8	94
	"	Pyrenees	3	....	1	1	1	6
	idaeus	Low Germany.	11	2	2	2	....	17
	"	Alps	7	1	1	..	1	10
	saxatilis	"	3	....	1	..	....	4
	villosus	Illinois	9	....	2	..	....	11
	occidentalis	"	1	1	..	..	....	2
Geum	rivale	Low Germany.	13	....	1	1	....	15
	"	Alps.	2	...	..	..	....	2
	urbanum	Low Germany.	..	....	1	1	....	2
	montanum	Alps.	3	....	19	1	4	27
	"	Pyrenees	1	2	4	..	....	7
	vernum	Illinois	1	....	..	..	....	1
	album	"	10	6	3	2	1	22
Fragaria	virginiana v. illinoensis	"	12	....	5	..	....	17
	vesca	Low Germany.	9	2	11	7	1	30
	"	Alps.	4	2	8	2	1	17
	"	Pyrenees	..	1	..	1	....	2
	elatior	Alps.	..	1	5	1	1	8

TABLE IV.

		Bees.	Other hymenoptera.	Diptera.	Coleoptera.	Other insects.	Total.....
Potentilla verna.....	Low Germany.	21	1	9	2	....	33
" and alpestris.....	Alps	13	4	29	1	2	49
"	Pyrenees.....	6	....	3	..	1	10
alpestris.....	"	1	....	2	..	....	3
reptans	Low Germany.	14	2	5	1	....	22
"	Pyrenees	..	....	1	..	....	1
anserina.....	Low Germany.	5	3	2	3	1	14
"	Alps	1	....	..	..	....	1
fruticosa	Low Germany.	2	2	16	2	....	22
tormentilla	"	3	....	4	..	1	8
"	Alps	..	....	1	1	2	4
"	Pyrenees	..	....	4	..	....	4
argentea.....	Low Germany.	8	1	4	3	....	16
minima.....	Alps	..	....	2	..	1	3
salisburgensis	"	4	....	15	2	3	24
aurea.....	"	5	2	27	3	15	52
grandiflora.....	"	8	4	16	4	13	45
caulescens.....	"	2	....	1	..	....	3
alchemilloides.....	Pyrenees	..	....	7	..	....	7
fragariastrum.....	"	..	1	1	..	1	3
rupestris	"	..	....	10	..	....	10
canadensis.....	Illinois	17	4	7	..	1	29
Agrimonia eupatoria	Low Germany.	1	....	10	..	....	11
Rosa canina.....	"	7	....	2	15	....	24
centifolia.....	"	11	3	5	16	....	35
rubiginosa.....	"	2	....	1	3	....	6
alpina.....	Alps	1	....	..	..	....	1
" ?.....	Pyrenees	..	....	2	..	....	2
sp.	"	..	....	1	..	....	1
humilis	Illinois	9	....	..	..	2	11
setigera.....	"	2	....	..	1	....	3
Pyrus malus.....	Low Germany.	9	1	6	..	....	16
communis.....	"	7	3	16	4	1	31
aucuparia.....	"	11	3	14	18	....	46
coronaria.....	Illinois	6	..	..	..	2	8
Crataegus coccinea..... ...	"	19	3	22	6	2	52
" v. mollis.....	"	19	4	15	4	1	43
crus-galli.....	"	32	8	20	3	3	66
oxycantha.....	Low Germany.	20	....	26	16	....	62
"	Pyrenees	1	....	2	1	....	4
Amelanchier vulgaris (Aronia rotundifolia).....	Alps	..	1	6	7	....	14
canadensis.....	Illinois	18	1	6	..	....	25

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DETERMINATIONS OF THE LATITUDE, LONGITUDE AND HEIGHT ABOVE SEA LEVEL OF THE LAWS OBSERVATORY OF THE UNIVERSITY OF THE STATE OF MISSOURI, CONTAINING A DESCRIPTION OF THE BUILDING AND PRINCIPAL INSTRUMENTS.

MILTON UPDEGRAFF.

Issued May 1, 1894.

THE LAWS OBSERVATORY OF THE STATE UNIVERSITY OF MISSOURI.

DETERMINATIONS OF THE LATITUDE, LONGITUDE AND HEIGHT ABOVE SEA LEVEL OF THE LAWS OBSERVATORY OF THE UNIVERSITY OF THE STATE OF MISSOURI, CONTAINING A DESCRIPTION OF THE BUILDING AND PRINCIPAL INSTRUMENTS.

By Milton Updegraff.

I. INTRODUCTION.

THE OLD OBSERVATORY.

The old Observatory of the University of Missouri was one of the first institutions of its kind west of the Allegheny mountains and was for many years the only astronomical observatory in the United States west of the Mississippi river. The building, which still exists as a part of the present Observatory, is a well built wooden structure, 44 feet long from east to west and 14 feet wide. It was completed in the spring of 1853 and cost $1,150. (See *Missouri Statesman* for July 8, 1853.) The old Observatory stood a few rods west of the old main building of the University, where the Physics and Engineering building now stands, and consisted of two parts, a transit-room 14x28 feet and a tower 14x14 about 15 feet high. The tower was surmounted by a cone which revolved on lignum vitae balls.

Under the revolving cone, mounted on a pier of masonry, was an equatorial refracting telescope by Fitz of New York. Its aperture was $4\frac{1}{16}$ inches and its focal length 5 feet 4 inches. This instrument was provided with a finding telescope, eye-pieces of powers ranging from 30 to 240 diameters and graduated circles in both right ascension and declination reading to 4 minutes of time and to 2 minutes of arc respectively. In the transit-room mounted on suitable

piers, were a $2\frac{1}{10}$-inch transit instrument by Brunner of Paris, an altitude and azimuth instrument by Simms of London, a theodolite of $1\frac{3}{8}$ inches aperture by Gregg and Rupp of New York, a sidereal clock by Stokel of New York and a mean time clock by Riggs of Philadelphia. A sextant with mercurial horizon, a barometer and thermometers completed the outfit. (See Annual Catalogue for 1857.)

The Observatory was built and equipped under the direction of Wm. W. Hudson, then Professor of Mathematics, Natural Philosophy and Astronomy, and afterward (1856–1859) President of the University. Professor Hudson was a man of high attainments in the exact sciences. In the construction of the old Observatory building many evidences of his excellent judgment and scrupulous care still exist. No records of any astronomical work which he may have done remain in the Observatory.

In 1865 Professor Joseph Ficklin was called to the chair of Mathematics and Astronomy. Prof. Ficklin filled the position with honor to himself and to the University until his untimely death, which occurred in September, 1887. The equipment of the Observatory remained about the same until 1878. According to the catalogue of the University for that year the sidereal clock by Stokel had been replaced by a sidereal clock by Gregg and Rupp of New York, and the altitude and azimuth instrument by Simms of London had been replaced by another instrument of the same kind of $2\frac{1}{8}$ inches aperture by Blunt of New York. It is highly probable, however, that no change of instruments was really made but that the names of the makers are incorrectly stated in the earlier University catalogues.

In the year 1878 a telegraph wire was run to the Observatory and the longitude approximately determined by comparing the local time as observed with the transit instrument, with time signals sent by telegraph from the Naval Observatory at Washington. The latitude, also, was approximately determined from observations with the altitude and azimuth instrument of the meridian altitudes of the sun and certain of the fixed stars. Prof. Ficklin also observed the transit of Mercury on May 6th of the same year. The old

Observatory was of course used chiefly for the purpose of instruction.

THE LAWS OBSERVATORY.

In January, 1880, the 4-inch Fitz telescope belonging to the Observatory and $500 were given in exchange for a $7\frac{1}{2}$-inch equatorial refracting telescope by Merz und Söhne of Munich, which was at that time the property of the Shelby High School at Shelbyville, Kentucky. The old Observatory building was removed to a better location on the northeast corner of the University campus and an octagonal brick tower with a hemispherical dome and a brick pier for the accommodation of the newly acquired telescope was built adjoining the east end of the transit room. The telescope was repaired and put in working order and was mounted on March 13th, 1880. All these improvements were made under the direction of Prof. Ficklin and are said to have cost more than $2,000. This sum of money was generously given from his private funds for the improvement of the Observatory by Dr. S. S. Laws, then President of the University.* At a meeting of the Board of Curators of the University held on June 2d, 1880, it was directed that "In recognition of the liberality of Dr. Laws for the advancement of Astronomical Science, the observatory and telescope shall be known and distinguished as the 'Laws Observatory and Telescope.'"

During July, 1882, Prof. Ficklin made an accurate determination of the latitude of the Observatory by Talcott's method, using for the purpose a zenith telescope belonging to the U. S. C. & G. Survey.

In July, 1883, a new sidereal clock, chronograph and spectroscope were purchased at the expense of the University from Fauth & Co. of Washington, D. C. The price paid for these instruments was $1,010.70. In 1881 a 20-inch celestial

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* The following statement is contained in each one of the annual catalogues of the University from 1879–80 to 1887–8 inclusive: —

"The present greatly improved condition of the Observatory is due to the liberality of the President, Dr. S. S. Laws, who for the advancement of astronomical science has given to the University more than two thousand dollars in order to procure the telescope and put it in complete working order, and to move and enlarge the Observatory building."

globe was added to the equipment of the Observatory. From the death of Prof. Ficklin in September, 1887, to July 1st, 1890, the Observatory was in charge of Wm. A. Cauthorn, Assistant Professor of Mathematics.

On taking charge of the Observatory about July 1st, 1890, I commenced the work of overhauling, cleaning and repairing the building and instruments. Observations for time with the transit instrument were commenced on July 24th, and observations with the equatorial telescope were begun early in November, 1890. During the summer of 1891 a wooden addition 15x30 for office and library room, with porch and stone basement, was erected adjoining the west end of the building. The cost of this improvement was about $900. A break-circuit sidereal chronometer by Bond & Son, of Boston, a barometer of $\frac{6}{10}$ inch bore by H. J. Green of Brooklyn, and a set of thermometers by the same maker were purchased about the same time at a cost of $350. A switch-board with the usual electrical connections was installed in the Observatory and a line of telegraph wire was run to the office of the W. U. Telegraph Co. in Columbia for the purpose of exchanging longitude signals. Numerous minor improvements were made in the building and instruments.

For a year and a half after the destruction by fire of the main building of the University on January 9th, 1892, the office, library-room and basement of the Observatory were occupied as class-rooms by professors whose lecture-rooms had been destroyed. Funds which would otherwise have been available for the further development of the Observatory were absorbed by the urgent demands to which the fire gave rise.

My time has been chiefly occupied with the work of instruction in the University. But transit observations for time have been maintained with some regularity and about one hundred micrometric observations of comets and minor planets have been made with the $7\frac{1}{2}$-inch telescope, and published in the astronomical papers. Various other astronomical observations have been made from time to time, and published whenever sufficiently valuable.

In conclusion I wish thankfully to acknowledge the aid,

financial and otherwise, which has at various times been given me by the Board of Curators of the University.

A statement of the cost of the Observatory as it now stands is appended. No account is taken of the cost of repairs.

COST OF OBSERVATORY AND EQUIPMENT.

Year.	For what Expended.	By whom Expended.	Amount.
1853	Old building	Board of Curators.	$1150
1853-7	Instruments	" " "	2000*
1880	7½-inch telescope, tower, dome and pier	Dr. S. S. Laws.	2000
1883	Instruments	Board of Curators.	1010
1891	Office and basement	" " "	900
1891	Instruments	" " "	350
			$7410
Deduct for Fitz telescope counted twice			300
Total cost of Observatory and instruments, excepting repairs			$7110
Cost of Observatory building, about			3100
Cost of instruments, about			4000

DESCRIPTION OF THE BUILDING AND PRINCIPAL INSTRUMENTS.

The Observatory Building is 84 feet long and from 14 to 30 feet wide. The octagonal brick tower which supports the dome of the equatorial telescope is 18 feet in diameter and about 18 feet high. The dome is 18 feet in diameter and its apex is 14 feet above the floor. It revolves on wheels that run on a cast iron track and is moved by a crank with gearing. The slit is 22 inches wide, runs slightly past the zenith and is closed by four trap-door shutters. The brick pier of the equatorial telescope has the shape of a square pyramid and rises to within two feet of the floor of the dome. It is covered by a capstone 4 feet square and 5 inches thick on which rests by four bearings the wooden stand on which the telescope is mounted. The foundations of this pier are 6 feet square, are laid 6 feet below the surface of the ground and are surrounded

* This amount is estimated.

at a distance of 4 inches by a brick wall carried up to the surface.

The transit room is 28x13 feet and 8 feet high, and has three slits 17 inches wide in the walls and roof for meridian observations. Each slit has a brick pier placed centrally under it and isolated from the floor and ground surface. The $2\frac{1}{10}$-inch transit instrument is mounted on the western pier. The sidereal clock is mounted on a brick pier 7 feet high, in the southwest corner of the room, and faces the transit instrument. The chronograph is mounted on the eastern pier and the central pier is usually occupied by the theodolite. The switch-board is on the south side and the barometer and the thermometer shelter on the north side of the transit room. The floor of the transit room is 742 feet above sea level.

The cone which shelters the $2\frac{1}{8}$ inch altitude and azimuth instrument is 13 feet in diameter at the base and its apex is 10 feet above the floor. It is divided into two equal parts by a slit 15 inches wide. The instrument is supported by a pyramidal brick pier more than 20 feet high.

The building is well finished throughout, is provided with suitable furniture and is lighted by gas. The office and basement are heated by wood stoves.

*The Equatorial Telescope.** This instrument is a refractor by Merz and Söhne of Munich of 7.45 inches clear aperture and 10 feet 8 inches focal length. It is mounted on a wooden

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* The following note concerning the history of this telescope is extracted from the University catalogue for 1884–5:—

This telescope was ordered in 1848 from the establishment of Merz & Mahler, of Munich, for the use of Shelby College, Shelbyville, Kentucky. It was received at Shelbyville in November, 1850, and cost, when mounted, $4,000. It was mounted under the direction of Prof. Joseph Winlock, and used by him while he was a professor in that institution. After Prof. Winlock went to Cambridge, Mass., he borrowed this telescope, and, in connection with Dr. B. A. Gould, established there the Cloverden Observatory. In "*Loomis's Recent Progress of Astronomy*," published in 1856, under the head of "Cloverden Observatory, Cambridge, Massachusetts," the following statement is made respecting this instrument, which was then the fourth in magnitude in the United States.

"The great telescope belonging to Shelby College was loaned to Prof. Joseph Winlock, and was removed to Cambridge, Massachusetts, where temporary accommodations were provided for it, and this establishment is known by the name of 'Cloverden Observatory.'" * * * "Numerous

stand which rests on the brick pier described above. The tube of the telescope is of polished mahogany and the other parts of the mounting are of steel and brass. The mechanical work is of the finest character throughout. Both lenses of the object glass are free from cracks and scratches and seem to be as good as when new. Yet both the optical quality of the telescope and the character of the mounting leave much to be desired as compared with instruments of more modern design.

The telescope is provided with graduated circles in both right ascension and declination, position filar micrometer, seventeen eye-pieces of powers ranging from 60 to 600 diameters, driving clock, finding telescope, solar attachment and spectroscope. The hour circle is 9.8 inches in diameter, is divided on silver to one minute of time and reads by two verniers to one second of time. The declination circle is 14.6 inches in diameter, is divided on silver to ten minutes of arc and reads by two verniers to ten seconds of arc.

The filar micrometer was no doubt furnished with the instrument by the makers. The value of one turn of the screw is 20.″82. Whole revolutions are read from a toothed wheel with index, and the micrometer head reads to thousandths of a revolution. The micrometer box can be moved only in position angle, but the so-called fixed thread is moved by a screw which has no graduated head. This arrangement renders measures of distance very inconvenient since it makes necessary a superposition of the wires for every observation of distance. The position circle is 4.3 inches in diameter, is divided on silver to quarter degrees and reads by two verniers to single minutes of arc. The threads may be illuminated with either bright or dark field.

The spectroscope is by Fauth & Co. and is provided with

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observations on comets, and on some of the newly discovered planets, have been made with this telescope by Dr. B. A. Gould and Prof. Joseph Winlock, some of which have been published in '*Gould's Astronomical Journal.*' This great telescope has recently been returned to Shelby College."

In 1869 Prof. Winlock, who was then Director of the Observatory of Harvard College, went with his assistants to Shelbyville, Kentucky, and there used this telescope in observing the total eclipse of the sun, which occurred on the 7th of August of that year.

both prism and grating. The grating is $\frac{9}{10}$ inch square, has 17,296 lines to the inch and was ruled by Chapman on Rutherford's engine. The clear aperture of the collimating and view telescopes is 1.4 inches, and their focal length is 15 inches. The view telescope is provided with a micrometer and an eyepiece which magnifies about 12 diameters. The slit is provided with a comparison prism, and the jaws of the slit are of brass.

The Transit Instrument is by Brunner of Paris and was made probably about 1850. The clear aperture of the telescope is 2.10 inches and its focal length is 23 inches. The spider-line reticule has five vertical threads about 3 seconds apart, and one horizontal thread. The illumination of the threads is effected by light which passes through a hole in one of the pivots and is reflected down the tube by a small mirror. The micrometer with which the instrument is provided is so constructed as to be practically useless. The diagonal eyepiece usually used was purchased of Fauth & Co. in 1891. Its power is 60 diameters, while that of the old one used until October 1, 1891, is 40. There is a reflecting cap for nadir observations.

The levels which were furnished with the instrument by the maker are almost worthless for purposes of precision on account of irregularity in the bore of the tubes. The striding level is the better one of the two, but an investigation made in June, 1890, showed that the average value of a division for one-half of the tube is 5″.4 and for the other half 3″.9. In April, 1891, these level tubes were replaced by new ones of excellent quality made by Fauth & Co. The adopted value of one division of the new striding level is $1''.869 \pm 0''.004$, and that of one division of the new latitude level is $1''.01 \pm 0''.01$.

The pivots are 0.74 inches in diameter, and repeated trials with the new striding level fail to show either inequality in their size or irregularity in their form. The distance between the ends of the pivots is 11.4 inches. The graduated circle in declination is 9.8 inches in diameter, is divided on silver to 5 minutes and reads very accurately by two verniers to three seconds of arc.

A portion of the weight of the telescope is taken off the pivots by adjustable springs which act upward against vertical bars of brass which carry the friction rollers. I was unable for many months to get good results from observations in right ascension made with the instrument. On June 9th, 1891, soon after getting the new levels the cause of the trouble was discovered. One of the pairs of friction rollers did not bear vertically against the axis but sidewise. This had the effect of sliding one of the pivots up the side of the wye by an amount not perceptible to the naked eye but easily detected by the level. This defect was easily corrected when found, by filing one side of the slot in which the bar works which carries the friction wheels.

The frame of the instrument is of cast iron painted white and is sufficiently heavy to insure a fair degree of stability. There is no reversing apparatus but the instrument is easily and safely reversed by hand. The character of the results which this transit is now capable of producing may be seen by reference to the observations for longitude given below.

The Sidereal Clock was purchased from Fauth & Co. in 1883. It has the Dennison Gravity Escapement and mercury compensation. The weight of the pendulum is 60 lbs. This clock is provided with a break circuit attachment and is solidly mounted on a brick pier in the southwest corner of the transit room. The pendulum swings from northwest to southeast in a plane which intersects the meridian at an angle of about 45°.

Of the other instruments in the Observatory the Chronograph by Fauth & Co., the Sidereal Break-circuit Chronometer, by Bond, the Sextant by Blunt, and the Barometer by H. J. Green are in every way first class. The Altitude and Azimuth instrument, Theodolite and Mean Time clock are of inferior quality. The smaller instruments and appliances with which the Observatory is provided render its equipment very complete.

II. THE LATITUDE.

The first observations for accurate determination of the latitude of this Observatory were made by Professor Joseph Ficklin in July, 1882. These observations were made by Talcott's Method and the instrument used was a zenith telescope belonging to the U. S. C. & G. Survey. The latitude was again determined by myself in July, 1891, by observing the transits of stars across the prime vertical with the two-inch transit instrument described above.

REDUCTION OF PROFESSOR FICKLIN'S OBSERVATIONS.

Soon after taking charge of the Observatory on July 1st, 1890, I found a partial record of these zenith telescope observations by Prof. Ficklin. There was also an incomplete record of Prof. Ficklin's reductions of the observations. All the records were on loose pieces of paper, some of which had been lost.

Twenty pairs of stars had been observed on three nights, July 13, 14 and 24, 1882. The original records of observations made on the last two nights were found, but the record for July 13th was missing. The computed results of observations for level division and micrometer revolution were found, but the original records had been lost, and a small fragment of the computations which remained gave no clue to any of the observations for determination of these constants.

The pairs of stars had been selected from the star catalogue of the U. S. C. & G. Survey and the declinations of the stars had been taken from the same source. (*See U. S. C. & G. Survey Report for 1876, Appendix No. 7.*)

On examining these observations it seemed to me worth while to re-reduce them using more accurate star places than were available when they were reduced by Prof. Ficklin.

No statement with reference to the instrument used was found among these records, but when looking over some old letters on file in the observatory, I discovered that the instrument was Zenith Telescope No. 3 of the U. S. C. & G.

Survey which had been loaned in June, 1882, to the University of Missouri by J. E. Hilgard, then Superintendent of the Coast Survey.

Description of the Instrument —

For the following facts concerning Zenith Telescope No. 3, I am chiefly indebted to Dr. T. C. Mendenhall, Supt. U. S. C. & G. Survey, writing under date of July 13th, 1892.

"Zenith Telescope No. 3 was made by Troughton and Simms. Its aperture was 3 inches, focal length 46 inches, power of diagonal eyepiece 61 diameters. The angular value of one turn of the micrometer screw adopted from 1850 to 1854 was 46″.63. For the same period one Div. of Level A = 1″.099, and one Div. of Level B = 1″.04.

"In 1874 a Coast Survey observer used the instrument and gave as follows: one turn of the micrometer screw = 46″.60 and one division of Level A = 1″.20.

"The instrument was sent to Prof. Joseph Ficklin of the University of Missouri on June 27th, 1882, by Prof. D. P. Todd of Amherst College, Massachusetts, and was returned to the Coast Survey Office in Washington by Prof. Ficklin in August, 1885.

"It was entirely reconstructed in 1891."

From the correspondence it appears that Prof. Todd determined the constants of the instrument, and found them not much different from the values of the level division and micrometer revolution determined by the Coast Survey in 1874. Unfortunately, these results were destroyed by fire in March, 1882. Prof. Todd reports that the instrument was in good condition when sent by him to Prof. Ficklin.

As determined by Professor Ficklin the angular value of one level division in terms of revolutions of the micrometer screw is

$$0^{r}.0269 = 1''.25.$$

The individual results for level division are not given.

Professor Ficklin's results for micrometer revolution are as follows:—

46″.32
46 .14
46 .37
46 .57
46 .72
46 .60
46 .62
46 .87
46 .35
46 .52
47 .14
46 .77
46 .73
47 .13

Mean value of 1 revolution = 46″.63 ± 0″.05.

These values of the instrumental constants agree fairly well with the values adopted by the Coast Survey in 1874. They were used by Prof. Ficklin in reducing the observations and are adopted in the reduction which follows. While the observations were being made the instrument was mounted in the transit room — probably on the central pier.

Re-reduction of the Observations. The values of the instrumental constants adopted in this reduction are:

1 Micrometer Revolution = 46″.63±0″.05
1 Division of Level = 1″.25

The average value of the micrometer correction is — 1.9 revolutions, so that an error in the adopted value of 1 revolution of the micrometer screw will affect the latitude by almost twice its full amount. But the previous determinations of the Coast Survey observers indicate that the adopted value is as near the truth as the probable error would indicate.

The pairs of stars observed by Prof. Ficklin are given in Table I. The error in choosing the stars of the eighteenth pair is due to a mistake of 9 degrees in the declination of

B. A. C. 7565 as given in the Coast Survey Catalogue, from which, as stated above, the pairs were selected. Prof. Ficklin actually observed on two nights an eighth magnitude star, Dm. 49°,3597, which happens to be very near the place given for B. A. C. 7565 in the Coast Survey Catalogue.

The mean declinations for 1875.0 of the stars observed, together with other useful data pertaining to them, have been furnished me by Prof. T. H. Safford, Director of the Field Memorial Observatory of Williams College, and I desire in this place to make grateful acknowledgment of his kindness. The declinations for 1875.0 of the stars with proper motions, probable errors, etc., as furnished by Prof. Safford are given in Table II. These declinations have been rigorously reduced to the system of declinations of the *Berliner Jahrbuch*. All the stars, excepting Groombridge 2865 are contained in Prof. Safford's Catalogue of 2018 Stars. But the declinations as given by Prof. Safford in Table II are deduced almost entirely from observations more modern than those available in 1876, when this catalogue was prepared. The average mean epoch of the observations used is 1875.

The reductions to apparent place have been made with the Independent Star Numbers of the American Ephemeris and corrections for proper motion during the year have been applied. The results of the observations of each pair are collected in Table III.

Weights. Of the results of 53 observations for latitude a few are so discordant that there can be no question as to the advisability or necessity rather of rejecting them. I have concluded to reject all observations whose results differ from the mean by more than three seconds. This excludes five of the 53 values of the latitude. They are marked with brackets in Table VI. The best observation rejected differs from the mean by 3″.4 and the most discordant observation retained differs from the mean by 2″.6.

In discussing in the usual manner the results of the remaining 48 observations I find that the probable error of the latitude resulting from a single observation of a pair is ± 0″.70. This includes the probable error of the half sum of the declinations. The probable error of one *observation*

comes out $\pm$ 0″.82. This anomalous result is in part due to the small average number of observations of each pair and indicates that the errors of the declinations of the stars are small as compared with the accidental errors of observation. In a case like this it is about as well to give the same weight to the results of the different pairs. Nevertheless the weight of the mean result for each pair has been computed by the usual formula, taking $e = \pm$ 0″.80.

$$P = \frac{1}{\varepsilon_{\delta}^{2} + \varepsilon_{\delta 1}^{2} + \frac{4e^2}{n}}$$

[See *Chauvenet, Vol. II, p. 356.*]

These computed weights are given in the last column of table VI. The simple mean of the 48 results for latitude is 38° 56′ 51″.628, and the weighted mean of the mean results for each pair is 38° 56′ 51″.645. The weighted mean is adopted and we have as the final result of this determination of the latitude of the pier of the transit instrument of the Laws Observatory,

$$\varphi = +38° 56′ 51″.645 \pm 0″.103 \text{ on July 17th, 1882.}$$

As before stated, the declinations of the stars used in this determination have been rigorously reduced to the system of declinations of the *Berliner Jahrbuch*, and therefore this value of the latitude must be considered as referred to the same system of declinations.

TABLE I.

Professor Ficklin's List of Latitude Stars.

Pair.	Star's Name.	Mag.	Right Ascension. 1882.0.	Declination. 1882.0.	Zenith Distance.
1	24 Bootis.	6	$14^h\ 24^m\ 32^s.6$	50°22′23.″80	—11°25′
	ε Bootis fol.	2.3	14 39 50 .0	27 34 20. 34	+11 23
2	ω Bootis.	5.4	14 56 56 .4	25 28 31. 02	+13 28
	B. A. C. 5071.	6	15 16 37 .0	52 23 2. 33	—13 26
3	ι Draconis.	3	15 22 18 .3	59 22 47. 47	—20 26
	χ Draconis.	4	15 43 25 .9	18 30 24. 55	+20 27
4	θ Draconis.	4.3	15 59 41 .0	58 52 50. 72	—19 56
	16 Herculis.	6.7	16 10 15 .1	19 6 24. 33	+19 51
5	β Herculis.	2.3	16 25 9 .0	21 44 51. 17	+17 12
	B. A. C. 5599.	6.5	16 35 37 .3	56 14 48. 00	—17 18
6	μ Draco. Mid.	5.4	17 2 53 .4	54 37 34. 00	—15 41
	73 Herculis.	6	17 19 10 .4	23 4 15. 20	+15 53
7	β Draconis.	3.2	17 27 46 .1	52 23 21. 10	—13 26
	87 Herculis.	6.5	17 44 2 .0	25 39 46. 78	+13 17
8	o Herculis.	4	18 2 56 .6	28 44 49. 50	+10 12
	B. A. C. 6255.	5	18 18 31 .4	49 3 44. 76	—10 7
9	c Draconis.	5.6	18 40 20 .6	55 25 13. 37	—16 28
	113 Herculis.	4.5	18 49 46 .0	22 29 47. 35	+16 27
10	16 Lyrae.	5.6	18 58 6 .0	46 46 4. 85	— 7 49
	19 Lyrae.	6	19 7 14 .5	31 5 13. 95	+ 7 52
11	β Lyncis.	3	19 25 57 .8	27 42 45. 36	+11 14
	Gr. 2865.	5.8	19 28 13 .6	50 3 15. 18	—11 6
12	B. A. C. 6986.	6.5	20 12 43 .4	40 0 1. 39	— 1 3
	40 Cygni.	6	20 23 11 .8	38 3 11. 87	+ 0 54
13	B. A. C. 7112.	6	20 30 2 .5	46 17 20. 73	— 7 20
	49 Cygni.	6.5	20 36 16 .1	31 53 17. 48	+ 7 4
14	T Cygni.	Var.	20 42 28 .1	33 56 27. 92	+ 5 1
	57 Cygni.	5.6	20 49 4 .3	43 56 27. 07	— 4 59
15	ξ Cygni.	4	21 0 38 .4	43 27 26. 82	— 4 30
	υ Cygni.	4.5	21 13 3 .8	34 24 6. 77	+ 4 33
16	B. A. C. 7444.	6	21 19 19 .6	25 40 3. 01	+13 17
	B. A. C. 7468.	6	21 22 52 .3	52 23 10. 61	—13 26
17	72 Cygni.	5.6	21 29 57 .3	38 0 19. 54	+ 0 57
	74 Cygni.	5	21 32 13 .2	39 53 1. 70	— 0 56
18	B. A. C. 7565.*	5.4	21 38 21 .2	40 36 58. 0	— 1 40
	15 Pegasi.	5.9	21 47 14 .1	28 14 30. 6	+10 42
19	B. A. C. 7746.	5.6	22 6 34 .8	50 14 26. 50	—11 17
	32 Pegasi.	5	22 15 52 .4	27 44 11. 48	+11 13
20	10 Lacertae.	5	22 33 58 .0	38 26 10. 77	+ 0 31
	12 Lacertae.	6	22 36 11 .8	39 36 33. 78	— 0 40

* Wrong declination given in Coast Survey Catalogue.

TABLE II.

MEAN PLACES FOR 1875.0 OF LATITUDE STARS AS FURNISHED BY PROFESSOR T. H. SAFFORD.

Pair.	Star's Name.	Declination 1875.0	Proper Motion.	Weight Mean Eq.	Mean Epoch.	P. E. Mean Eq.	P. E. 1882.
1	24 Bootis.	50°24′17.″7	—0.″067	10½	77.5	±0.″14	±0.″14
	ε Bootis fol.	27 36 8. 0	+0. 001	17½	75.6	0. 12	0. 13
2	ω Bootis.	25 30 12. 0	—0. 048	7½	77.5	0. 16	0. 17
	B. A. C. 5071.	52 24 34. 2	0. 00	3½	78.7	0. 24	0. 27
3	ι Draconis.	59 24 16. 5	+0. 022	39½	73.3	0. 07	0. 09
	ϰ Serpentis.	18 31 44. 0	—0. 083	19½	72.1	0. 10	0. 12
4	θ Draconis.	58 53 58. 7	+0. 345	44½	73.3	0. 07	0. 09
	16 Herculis.	19 7 29. 7	—0. 084	3½	69.1	0. 24	0. 26
5	β Herculis.	21 45 47. 8	—0. 012	36½	74.3	0. 07	0. 09
	B. A. C. 5599.	56 15 38. 0	+0. 08	2½	80.4	0. 28	0. 29
6	μ Draco. mid.	54 38 8. 1	+0. 078	14½	72.6	0. 12	0. 13
	73 Herculis.	23 4 40. 4	—0. 032	6½	78.7	0. 18	0. 18
7	β Draconis.	52 23 40. 8	+0. 004	41½	69.6	0. 07	0· 09
	87 Herculis.	25 39 56. 9	—0. 037	6½	75.4	0. 18	0. 18
8	ο Herculis.	28 44 47. 8	—0. 001	28½	69.7	0. 08	0. 11
	B. A. C. 6255.	49 3 33. 0	+0. 07	8½	76.9	0. 15	0. '17
9	c Draconis.	55 24 48. 7	+0. 018	11½	77.2	0. 13	0. 14
	113 Herculis.	22 29 17. 1	+0. 014	7½	76.4	0. 16	0. 17
10	16 Lyrae.	46 45 30. 4	—0. 10	2½	79.3	0. 28	0. 30
	19 Lyrae.	31 4 33. 4	+0. 005	8½	76.7	0. 16	0. 16
11	β Cygni.	27 41 54. 1	—0. 013	39½	71.2	0. 07	0. 09
	Gr. 2865.	50 2 22. 5	+0. 05	7	74.5	0. 17	0. 21
12	B. A. C. 6986.	39 58 44. 7	—0. 01	3	73.7	0. 26	0. 28
	40 Cygni.	38 1 50. 1	—0. 040	5½	77.1	0. 19	0. 20
13	B. A. C. 7112.	46 15 55. 3	0. 00	2½	79.3	0. 28	0. 29
	49 Cygni.	31 51 49. 2	—0. 016	6½	74.4	0. 18	0. 19
14	T Cygni.	33 54 56. 6	0. 00	3	80.6	0. 26	0. 30
	57 Cygni.	43 54 52. 8	—0. 014	5½	59.0	0. 19	0. 23
15	ξ Cygni.	43 25 47. 4	—0. 008	29½	70.3	0. 08	0. 10
	υ Cygni.	34 22 22. 1	—0. 004	6½	76.8	0. 18	0. 18
16	B. A. C. 7444.	25 38 15. 8	0. 00	7½	65.0	0. 16	0. 26
	B. A. C. 7468.	52 21 22. 0	0. 00	4	80.2	0. 22	0. 23
17	72 Cygni.	37 58 27. 5	+0. 105	9½	75.8	0. 15	0. 15
	74 Cygni.	39 51 9. 5	+0. 009	27½	75.7	0. 09	0. 09
19	B. A. C. 7746.	50 12 22. 7	+0. 042	9½	77.5	0. 15	0. 15
	32 Pegasi.	27 42 5. 4	—0. 003	7½	75.7	0. 16	0. 17
20	10 Lacertae.	38 24 0. 2	0. 000	20	73.7	0. 10	0. 12
	12 Lacertae.	39 34 22. 7	+0. 003	4½	77.0	±0. 21	±0. 21

TABLE III.

Summary of Results.

Pair.	Prob. Error of $\frac{\delta + \delta^1}{2}$	LATITUDE.			Mean φ for Each Pair.	Wt.
		July 13.	14	24		
1	±0″.10	38°56′	[55″.73]		38°56′	
2	±0 .16	51″.06	[63 .48]		51″.06	0.4
3	±0 .08		52 .50	51″.39	51 .94	0.8
4	±0 .14	51 .28	51 .11	51 .76	51 .38	1.1
5	±0 .15	51 .28	51 .55	53 .02	51 .95	1.1
6	±0 .11	51 .35	52 .67	51 .55	51 .86	1.1
7	±0 .10	[47 .45]	52 .70	51 .69	52 .19	0.8
8	±0 .10	[59 .03]	52 .66	51 .85	52 .26	0.8
9	±0 .11	50 .72	52 .70	51 .76	51 .73	1.1
10	±0 .17	50 .72	51 .98	50 .88	51 .19	1.0
11	±0 .11	52 .57	50 .55	51 .50	51 .54	1.1
12	±0 .20	49 .75	51 .96	51 .99	51 .23	1.0
13	±0 .17	51 .23	51 .62	49 .77	50 .87	1.0
14	±0 .19	53 .64	50 .55	48 .95	51 .05	1.0
15	±0 .10	53 .41	52 .38	51 .84	52 .54	1.1
16	±0 .17	50 .25	50 .79	52 .49	51 .18	1.0
17	±0 .09	[48 .25]	49 .21	53 .20	51 .20	0.8
19	±0 .11	50 .68	51 .86	52 .75	51 .76	1.1
20	±0 .12	53 .94	51 .70	51 .39	52 .34	1.1
		38°56′51″.563	51″.676	51″.634	38°56′51″.645	±0″.103

Epoch July 17.0 1882.

DETERMINATION OF THE LATITUDE BY OBSERVATION OF TRANSITS OF STARS ACROSS THE PRIME VERTICAL.

In July, 1891, I determined the latitude of this Observatory by Bessel's Method of Prime Vertical transits. The observations were made with the $2\frac{1}{10}$-inch transit instrument, which was mounted on the pier of the altitude and azimuth instrument in the cone. Besides the transit instrument the Fauth sidereal clock and the chronograph were used. All these instruments have been described above. The clock, which had been running badly, was taken down and cleaned on July 13th, two days before the observations were commenced. Its correction was determined as fre-

quently as possible by removing the transit instrument to its usual place in the transit room and observing for time. The results of observations for ΔT of the sidereal clock for the period July 14 to August 1 follow.

ΔT AND RATES OF FAUTH SIDEREAL CLOCK.

Date 1891.	Sidereal Time.	FΔT	Daily Rate.	Hourly Rate.	Temp. Fahr. in Clk. Case.
July 14	17h. 55m.	+ 5s.58			
" 17	21 0	— 7 .05	—4s.03	—0s.168	69°.5
" 18	19 0	—10 .87	—4 .16	—0 .173	70 .5
" 19	17 30	Clock stopped	and pend. bob	turned down 3	divs.
" 19	18 49	+ 1s.04			
" 21	16 26	— 1 .03	—1s.09	—0s.045	73 .2
" 24	20 55	— 4 .93	—1 .23	—0 .051	69 .4
" 29	21 42	—10 .13	—1 .03	—0 .043	70 .7
Aug. 1	17 6	—13 .47	—1 .19	—0 .050	72 .2

The Observations were made on six nights in July, 1891. The new diagonal eye-piece of the transit instrument had not yet been purchased and the old one, power 40 diameters, had to be used. The verticality of the threads of the reticule was adjusted with great care but all observations of transits were made near the horizontal thread. The stars were observed on the chronograph and over all five threads of the reticule. The instrument was accurately adjusted in the prime vertical by means of B. J. stars, which transit the prime vertical at a low altitude, and in no case has the correction to the latitude for error of the azimuth been appreciable. The inclination of the axis of the instrument was measured seven or eight times each night with the new striding level. The value of one division of this level was accurately determined in June, 1891, by myself at the Washburn Observatory, Madison, Wisconsin. The adopted result of this determination is —

$$1 \text{ Div.} = 1''.784 \pm 0''.015.$$

The results of the level observations for each night were plotted in a curve and the inclination of the axis at the time of each observed transit was read off the curve. Careful tests

with the striding level indicate that the pivots are sensibly equal in diameter and show no evidence of irregularity in their form. But all possible error arising from inequality in the diameters of the pivots has been eliminated by the reversal of the instrument. The collimation was reduced by adjustment to less than half a second of time before work was commenced and it remained very nearly constant during the entire series of observations. The instrument was never reversed during a night's work. The circle was *south* on July 17, 23 and 25, and *north* on July 15, 24 and 29.

As there were no means of determining the clock ΔT on each night while the prime vertical observations were being made I determined to observe only those stars which could be conveniently observed at both east and west transit. The four *Berliner Jahrbuch* stars, π Herculis, θ Herculis, α Lyrae and θ Lyrae were selected for this purpose. This determination of the latitude depends on the declinations of these four stars. They were all observed with the Repsold meridian circle of the Washburn Observatory during the years 1888–9, and the corrections given below have been taken from Vol. VIII of the Publications of that Observatory. These declinations were deduced from the nadir point of the instrument and have not been reduced to the declination system of the *Berliner Jahrbuch*. The corrections to the B. J. declinations indicated are given below. They confirm in a general way the accuracy of the B. J. declinations. The apparent declinations of these stars as given in the B. J. for 1891 have been adopted.

	$\Delta\,\delta$	No. Obs.
π Herculis	+ 0″.62	4
θ Herculis	+ 0 .03	9
α Lyrae	— 0 .25	6
θ Lyrae	+ 0 .46	12

The Observations were Reduced by a slight modification of the method of Professor Benjamin Pierce as presented in *Chauvenet's Spherical and Practical Astronomy, Vol. II, p. 255.* By this method the observations of the different nights are reduced in pairs, the circle having been *south* on one night

and *north* on the other. The thread intervals of the reticule do not need to be known, and if the error of collimation remains constant its effect is wholly eliminated from the result.

By this method it is customary to reduce the transits of a star across each thread separately and when the thread intervals are entirely unknown it is necessary to do so. The mean of the results for any thread *circle south* and *circle north*, corrected by a small quantity $\Delta\,\varphi$ gives a value of the latitude. But when the thread intervals of the reticule are approximately known, the labor of the computations may be very much reduced without sacrifice of rigor by computing the correction for reducing the mean of the transits across the threads to the time of transit across the mean of the threads. This correction may be applied directly to the mean of the transits across the threads, or it may be used to compute a correction to the latitude deduced on the supposition that the mean of the transits across the threads is the time of transit across the mean of the threads. The effect of any small error in the assumed thread intervals is eliminated by the reversal of the instrument. The formulae necessary for the computation of this correction are to be found on pages 246 and 248 of *Chauvenet's Spherical and Practical Astronomy, Vol. II.*

This abbreviated process was employed in the reduction. The equatorial thread intervals from the mean of the threads which were used in computing the corrections $\Delta\,\varphi_s$ and $\Delta\,\varphi_n$ were determined in September, 1890. They are —

A	B	C
$-6^s.25\pm0^s.01$	$-3^s.20\pm0^s.01$	$-0^s.08\pm0^s.01$

D	E
$+3^s.09\pm0^s.01$	$+6^s.44\pm0^s.01$

The intervals had no doubt changed somewhat but, as above stated, they do not need to be known accurately for this purpose.

The observations of four stars at both east and west trans-

its on six nights give twelve independent determinations of the latitude which are arranged in the following table.

SUMMARY OF RESULTS OF LATITUDE FROM PRIME VERTICAL TRANSITS.

Star.	Circle.	Date 1891.	φ_s and φ_n.	φ_s minus φ_n.	φ
π Herculis..	S	July 17	+38° 56′ 55″.85	+7″.53	+38° 56′ 52″.08
	N	" 15	48 .32		
θ Herculis..	S	" 17	57 .36	8 .26	53 .23
	N	" 15	49 .10		
α Lyrae.....	S	" 17	57 .47	9 .98	52 .48
	N	" 15	47 .49		
θ Lyrae.....	S	" 17	54 .99	7 .18	51 .40
	N	" 15	47 .81		
π Herculis..	S	" 23	54 .81	6 .74	51 .44
	N	" 24	48 .07		
θ Herculis..	S	" 23	55 .44	6 .85	52 .02
	N	" 24	48 .59		
α Lyrae.....	S	" 23	54 .34	6 .78	50 .95
	N	" 24	47 .56		
θ Lyrae.....	S	" 23	54 .46	6 .36	51 .28
	N	" 24	48 .10		
π Herculis..	S	" 25	54 .69	6 .15	51 .62
	N	" 29	48 .54		
θ Herculis..	S	" 25	55 .23	5 .77	52 .34
	N	" 29	49 .46		
α Lyrae.....	S	" 25	55 .79	7 .72	52 .22
	N	" 29	48 .66		
θ Lyrae.....	S	" 25	54 .81	+5 .59	+38 56 52 .02
	N	" 29	+38 56 49 .22		+38° 56′ 51″.923

In combining these results for the final value of the latitude for this epoch, the mean results for each of the four stars have been given the same weight, or what is the same thing, the simple mean of the twelve determinations is adopted, and we have —

$$\varphi = +38^\circ\ 56'\ 51''.923 \pm 0''.121 \text{ on July 22d, 1891.}$$

REDUCTION TO MEAN LATITUDE.

Since the fact of variation of latitudes periodically by a sensible amount seems to have been established beyond reasonable doubt, it remains to reduce the above determinations of latitude to the mean value for this place. Any minute secular change of latitudes which may exist is so small that

even its sign is as yet unknown. Chandler's periodic law for variation of latitude for the meridian of Greenwich, as expressed in his formulae (15), (16) and (17) is —

$$\varphi - \varphi_0 = -0''.12 \cos(t - T_1) \times 0^\circ.835 - \tau_2 \cos(\odot + 10^\circ) \quad (15)$$

$$T_1 = 2406193 \text{ (1875 Nov. 1)} + 431 \text{ E} \quad (16)$$

$$r_2 = 0''.047 + 0''.003\tau + 0''.00025\tau_2 \quad (17)$$

[*See Ast. Jour. No. 277, Vol. XII, P. 100.*]

In which —

φ_0 = the mean latitude.
φ = the latitude at time t.
$\odot$ = the sun's longitude.
τ = interval in years, positive after 1875.
E = The whole number of times 431 is contained in the number of mean solar days between a given date t and the epoch Nov. 1, 1875.

For points not on the meridian of Greenwich this formula must be corrected for longitude by adding the longitude expressed in arc to the quantities $(t - T_1) \times 0^\circ.835$ and $\odot + 10^\circ$.

By this formula, for Columbia, July 17th, 1882, $\varphi - \varphi_0 = -0.''048$, and for July 22d, 1891, $\varphi - \varphi_0 = +0''.222$.

The latitude determination of July 17th, 1882, by Prof. Ficklin using Talcott's Method gave

$$\varphi = +38^\circ\ 56'\ 51''.645 \pm 0''.103.$$

The determination from P. V. Transits by myself, whose mean epoch is July 22nd, 1891, gives

$$\varphi = +38^\circ\ 56'\ 51''.923 \pm 0''.121.$$

Applying the above reductions from mean to true latitude with signs changed we get for the two values of the mean latitude of this Observatory:

Epoch.	*Observer.*	*Mean Latitude.*
July 17, 1882.	Ficklin	$+38^\circ\ 56'\ 51''.69 \pm 0''.10$
July 22, 1891.	Updegraff	$+38\ \ 56'\ 51\ .70 \pm 0''.12$

The mean

$$38^\circ\ 56'\ 51''.70 \pm 0''.08$$

is adopted as the mean latitude of the center of the pier of the 2-inch transit instrument in the transit room of this Observatory.

The close agreement of these two determinations of the mean latitude must, of course, be taken as largely accidental, since it is so much closer than can be expected in the nature of the case.

I have however effectually guarded myself against any possible bias of judgment in reducing and discussing the observations, by keeping myself in total ignorance of the corrections for latitude variation until the reductions were finished. The final results, as given above, of both determinations of the latitude were deduced and adopted before I had any knowledge whatever concerning the reductions to mean latitude, which were computed afterward.

III. THE LONGITUDE.

The longitude of this Observatory was determined by exchange of telegraphic signals with the Observatory of Washington University, St. Louis, on October 25, 26, 28, 29 and November 2, 1891. Good observations for clock correction were secured on all these nights both in Columbia and in St. Louis. The signals exchanged on the first three nights were automatic, on the last two nights they were arbitrary.

The Observations at Columbia were made by myself with the $2\frac{1}{10}$-inch transit instrument of this Observatory, mounted in its usual place on the west pier in the transit-room. For a description of the instrument see page 488. The new diagonal eye-piece of power 60 was used.

On each night a complete determination of the clock correction and instrumental constants was made both before and after the time of exchange. About 35 stars were observed on each night and only stars of the American Ephemeris and the *Berliner Jahrbuch* were used. The stars were so selected

that the average azimuth factor for the time stars is small, and the reversal of the instrument eliminates any small error in the adopted value of the collimation.

All transits of stars were observed near the horizontal thread of the reticule and over all five of the vertical threads. The observed time used is the mean of the transits across the five threads. The time stars were observed on the chronograph and the circumpolar stars used for the determination of azimuth were observed by eye and ear from the clock beats. A careful investigation shows no sensible difference between the results of these two methods of observing. No incomplete transits were observed but I have nevertheless deduced from 12 eye and ear observations of circumpolar stars the following equatorial intervals of the threads of the reticule from the mean of the threads. The threads are lettered A, B, C, D, E, in order of transit of a star at upper culmination, Circle West, when the micrometer-head is turned toward the clamp.

Equatorial Intervals from Mean of Threads of $2\frac{1}{10}$-inch Brunner Transit, October, 1891.

A $-6^s.252 \pm 0^s.007$
B $-3\ .164 \pm 0\ .007$
C $-0\ .070 \pm 0\ .007$
D $+3\ .112 \pm 0\ .007$
E $+6\ .372 \pm 0\ .007$

The inclination of the axis of the instrument was measured with the new striding level about 15 times each night. The levels for each night were plotted in a curve and the value of the level for each star was read off the curve. The adopted angular value of one division of this level as determined in October and November, 1891, by means of a level trier loaned by the Mississippi River Commission is —

$$1 \text{ div.} = 1''.869 \pm 0''.0045 = 0^s.125 \pm 0^s.0003.$$

The correction for inequality of the pivots of the instrument has been found to be $0^s.000$.

The sidereal clock of the Observatory was used as the time-

piece at Columbia. For a description of it see page 489. Its running while the observations were in progress was only fair, and a month later, its performance growing worse, it was stopped and repaired by a local jeweler who found that there was something wrong with the escapement.

Observations at St. Louis. The observations in St. Louis were made by Prof. H. S. Pritchett with the 3-inch Fauth Transit of the Observatory of Washington University, mounted on the western pier in the transit room. The focal length of the instrument is 48 inches, and the power of the diagonal eye-piece used is 125 diameters. The inclination of the axis was measured by means of the striding level, the angular value of one division of which is

$$2''.156 \pm 0''.005 = 0^s.144 \pm 0^s.0003.$$

The adopted correction for inequality of pivots is $+0^s.015$. The reticule consists of seven vertical and two horizontal lines ruled on a glass plate. The equatorial intervals between the vertical lines and the mean of the threads as determined from 17 transits of circumpolar stars are as follows: The threads are lettered A, B, C, D, E, F, G, in the order of transit of a star U. C. when the circle is West.

Equatorial Intervals of Glass Reticule of Fauth Transit Instrument of Washington University.

October, 1891.

A	$-13^s.428 \pm 0^s.007$
B	-8.911 ± 0.007
C	-4.466 ± 0.007
D	-0.010 ± 0.007
E	$+4.432 \pm 0.007$
F	$+8.927 \pm 0.007$
G	$+13.456 \pm 0.007$

Both times stars and circumpolar stars were observed on the chronograph, and usually, over the seven wires of the reticule. The mean of the seven threads is the observed time used. In case of incomplete transits the threads observed have been reduced to the mean of the threads with the above

intervals. Only stars of the *Berliner Jahrbuch* and the American Ephemeris were used and the average number observed each night is 20. As at Columbia, a complete determination of the clock error and instrumental constants was made both before and after exchange of signals, and by reversal of the instrument and judicious selection of the stars observed, the azimuth and collimation constants were well determined and their effect eliminated as far as possible from the clock ΔT.

The time-piece used at St. Louis was sidereal clock Howard No. 214 of the Observatory of Washington University.

Reduction of the Observations at Columbia and St. Louis. The observations at Columbia and St. Louis were both reduced by myself. With a single exception the right ascensions of the stars were taken when possible from the apparent places of the *Berliner Jahrbuch*. The right ascensions of those stars of the American Ephemeris which are not contained in the B. J. were taken from the apparent places of the American Ephemeris and reduced to the B. J. system by means of the corrections given for that purpose in the B. J. of 1884. In case of a few B. J. stars whose apparent places are not given, the reduction from mean to apparent place was computed with the Independent Star Numbers of the American Ephemeris. In case of the star 61 Cygni the place given in the Am. Eph. was used in preference to that given in the B. J. and the correction for reduction to the B. J. system was applied.

Two complete reductions were made of the observations at Columbia and also of those made at St. Louis. The first or preliminary reduction was made by a method of my own published in No. 238 of the Astronomical Journal. Following this method, the corrections for level, diurnal aberration and for an approximate value of the collimation were applied to the observed times. The observed times thus corrected were subtracted from the right ascensions of the stars, giving as a remainder a quantity M which is the clock ΔT uncorrected for azimuth and also uncorrected for whatever error there may be in the assumed collimation. We then have for each star *circle west* an equation of the form $\Delta T_w = -a_w A + M$ in which

A is the azimuth factor, and ΔT_w and a_w are the clock correction and azimuth constant *circle west* uncorrected for error in the assumed collimation. Taking the means of the quantities M and A for all the time stars *circle west* we have the equation.

$$\Delta T_w = - a_w A_t + M_t.$$

In like manner

$\Delta T_w = - a_w A_p + M_p$ in which A_p and M_p are the means of the quantities A and M for the circumpolar stars *circle west.* From equations of this form representing the group of stars observed *circle west*, were deduced the quantities ΔT_w and a_w The observations *circle east* were treated in the same way, giving ΔT_e and a_e which are the clock correction and azimuth *circle east* uncorrected for the error of the assumed collimation.

Then, for the observations *circle west* was written an equation of this form —

$$\Delta T = \Delta T_w + \Delta c K_w \qquad \text{(A.)}$$

in which Δc is the correction to the assumed collimation and K_w is the differential co-efficient of ΔT with respect to c. The numerical value of K_w was computed by the formula

$$K_w = A_t \frac{C_t - C_p}{A_t - A_p} - C_t$$

in which C_t is the mean of the collimation factors of the time stars *circle west* and C_p the mean of the collimation factors of the polar stars. For the observations *circle east* was written the equation

$$\Delta T = \Delta T_e - \Delta c K_e \qquad \text{(B.)}$$

in which K_e is found by a formula strictly analogous to that for K_w. From the equations (A) and (B) formed from the observations *circle west* and *circle east* were computed ΔT and Δc. The mean of the right ascensions of the time-stars was taken as the epoch of ΔT.

In this preliminary reduction the time-stars were all

given equal weight, and the azimuths given by the circumpolar stars were weighted according to the judgment of the computer.

The values of the collimation deduced by this method from the observations of each night are given in the following table:—

RESULTS FOR COLLIMATION DEDUCED FROM THE PRELIMINARY REDUCTION.

DATE 1891.	Collimation.	
	Columbia Transit Inst.	St. Louis Transit Inst.
October 25	+0^s.407	—0^s.218
" 25	0 .329	0 .212
" 26	0 .314	0 .264*
" 26	0 .412	0 .225
" 28	0 .325	0 .194
" 28	0 .392	0 .209
" 29	0 .320	0 .207
" 29	0 .327	0 .238
November 2	+0 .356	0 .219
" 2	.....	—0 .202
Means	+0^s.354	—0^s.216

These results show, in case of each instrument, little or no evidence of change in the collimation constant and in the reduction of the observations by the Method of Least Squares the mean values of the collimation as found above were adopted as the true values. The effect of any small error in these adopted collimations is eliminated by the reversal of the instruments. This reduces the number of unknown quantities to two, ΔT and a, thus diminishing very much the labor of computation.

In the reduction by Least Squares the stars were given weights depending on the declinations. The Coast Survey system of weights was used, then an observation equation was

* This determination is given one-half weight because of poor determination of the azimuth.

written for each star, normal equations formed, and the most probable value of ΔT and a deduced in the usual way.

The average difference between the values of ΔT deduced by these two methods is in this case less than $0^s.005$.

The probable error of one ΔT from a time star at Columbia as given by these observations is $\pm 0^s.059$ and at St. Louis it is $\pm 0^s.053$. The probable error of the clock correction as determined before or after exchange is for Columbia $\pm 0^s.015$ and for St. Louis $\pm 0^s.019$. Aside from the uncertainty due to personal equation, the probable error of the mean $\Delta\lambda$ from the five nights is about one-hundredth of a second.

Personal Equation Observations. Observations for difference of personal equation were made in St. Louis on November 6, 17 and 18, 1891. The Columbia transit instrument was taken to St. Louis and mounted on the eastern pier in the transit room of the Observatory of Washington University, about five feet east of the pier on which the St. Louis transit instrument stands. The same stars were observed simultaneously by myself and Professor Pritchett, using the same clock but different chronographs. Observations of both time stars and polars were made in both positions of the instruments, and every precaution was taken in both the observations and reductions for the accurate determination of the clock correction and the instrumental constants. The results given below are so discordant that they must be considered as giving only a rough approximation to the correct result.

Date 1891.	Clock ΔT.		P.—U.	No. Stars.
	Pritchett.	Updegraff.		
November 6.....	$+58^s.507$	$+58^s.617$	$-0^s.110$	13
" 17.....	+55 .836	+55 .505	+0 .331	13
" 18.....	+55 .870	+55 .627	+0 .243	11
" 18.....	+55 .806	+55 .713	+0 .093	9
			$+0^s.139$	
Correction for dist. between piers....	.....	.....	$-0^s.005$	
			$+0^s.134$	

On November 18th, at the suggestion of Professor Pritchett, four stars were observed for determining the difference of personal equation by a different method. Using the St. Louis transit a star was observed across the first three lines of the reticule by observer P. and over the last three lines by observer U. For another star the observers changed about, U. observing over the first three lines and P. over the last three. Since the power of the eye-piece of the St. Louis transit is more than double that of the eye-piece on my own instrument this method is open to serious criticism. The personal equation may and probably does depend very largely on the rapidity of motion of the star in the field. However, the results as given below for the four stars observed by this method are so accordant that it is to be regretted that more observations of this kind were not secured.

Star.	Decl.	P.	U.	P.—U.
ι Pisc.	+ 5° 3′	$27^s.05$	$26^s.93$	$+0^s.12$
φ Pegasi.	+18° 32	2 .97	2 .72	+0 .25
ω Pisc.	+ 6 17	49 .45	49 .35	+0 .10
33 Pisc.	— 6 18	51 .96	51 .78	+0 .18
				$+0^s.162$

These two results for personal equation seem on the whole to be entitled to about equal weight and their mean — $0^s.148$ is adopted as the correction to be applied to $\Delta\lambda$ for difference of personal equation between observers. The value of $\Delta\lambda$ given by the Last Square reduction when thus corrected for personal equation is

$$+ 8^m\ 29^s.171 \pm 0^s.04.$$

The probable error of this result is estimated, and consists chiefly of the uncertainty of the determination of the correction for personal equation.

The longitude of the west pier in the transit room of the Observatory of Washington University — that is the pier of the 3-inch transit instrument — is $6^h\ 0^m\ 49^s.163$ as determined

in the year 1882 by the U. S. C. & G. Survey from an adjustment of a network of longitudes including St. Louis. We then have as the longitude from Greenwich of the west pier in the transit room of this Observatory

$$6^h\ 9^m\ 18^s.33 \pm 0^s.04.$$

The longitude of the Laws Observatory of the University of the State of Missouri is west from —

Washington (New Naval Obs'y)	$1^h\ 1^m\ 2^s.62 = 15°\ 15'\ 39''.3$
Washington (Old Naval Obs'y)	1 1 6 .29 = 15 16 34 .3
Greenwich	6 9 18 .33 = 92 19 35 .0
Paris	6 18 39 .28 = 94 39 49 .2
Berlin	7 2 53 .24 = 105 43 18 .6

In making this longitude determination I was fortunate in receiving generous aid from every one who could in any way contribute to the success of the work. I am under especially deep obligation to Professor Pritchett for the share of the astronomical work which he voluntarily performed, and also to him and to Professor William Trelease, Director of the Shaw Gardens, and to Mrs. Trelease for courtesies extended to me while in St. Louis observing for difference of personal equation. I am also indebted to Mr. Chas. M. Hays, General Manager (now Vice-President) of the Wabash Railroad, for free transportation between Columbia and St. Louis during the progress of the work; to Col. R. C. Clowry, Vice-President and General Superintendent of the W. U. Tel. Co., for free use of their wires between Columbia and St. Louis, and to Mr. E. F. Ammerman, the local agent of the W. U. Tel. Co. for valuable assistance at this end of the line.

COMPARISONS OF COLUMBIA CLOCK WITH SIGNALS RECEIVED FROM ST. LOUIS.

Date 1891.	Columbia Clock.	Columbia Clock Correction.		St. Louis Clock.	St. Louis Clock Correction.	
		Preliminary Reduction.	Least Square Reduction.		Preliminary Reduction.	Least Square Reduction.
Oct. 25	23h. 7m. 50s.748	—19s.626	—19s.627	23h. 15m. 0s.000	+1m. 0s.396	+1m. 0s.396
" 26	22 45 50 .583	—19 .694	—19 .689	22 53 0 .000	+1 0 .190	+1 0 .193
" 28	22 44 49 .692	—18 .880	—18 .874	22 52 0 .000	+1 0 .078	+1 0 .073
" 29	22 56 25 .400	—18 .365	—18 .360	23 3 36 .418	+0 59 .912	+0 59 .910
Nov. 2	23 2 22 .612	—16 .033	—16 .028	23 9 36 .800	+0 59 .071	+0 59 .071

COMPARISONS OF ST. LOUIS CLOCK WITH SIGNALS RECEIVED FROM COLUMBIA.

Date 1891.	Columbia Clock.	Columbia Clock Correction.		St. Louis Clock.	St. Louis Clock Correction.	
		Preliminary Reduction.	Least Square Reduction.		Preliminary Reduction.	Least Square Reduction.
Oct. 25	23h. 0m. 0s.000	—19s.630	—19s.631	23h. 7m. 9s.327	+1m. 0s.400	+1m. 0s.399
" 26	22 49 0 .000	—19 .697	—19 .691	22 56 9 .524	+1 0 .191	+1 0 .193
" 28	22 54 0 .000	—18 .878	—18 .871	23 1 10 .394	+1 0 .081	+1 0 .078
" 29	22 57 43 .077	—18 .365	—18 .360	23 4 54 .153	+0 59 .912	+0 59 .910
Nov. 2	23 7 37 .879	—16 .032	—16 .028	23 14 52 .114	+0 59 .066	+0 59 .067

RESULTS OF PRELIMINARY REDUCTION OF OBSERVATIONS FOR LONGITUDE ST. LOUIS TO COLUMBIA.

Date 1891.	Signals Received at Columbia.		Signals Received at St. Louis.		Difference of Time.	$\Delta\lambda$	Wave and Armature Time.
	Columbia Clock. $+\Delta T$.	St. Louis Clock. $+\Delta T$.	Columbia Clock. $+\Delta T$.	St. Louis Clock. $+\Delta T$.			
Oct. 25	23h. 7m. 31s.122	23h. 16m. 0s.396	h. m. s.	h. m. s.	8m. 29s.274	m. s.	s.
Oct. 25			22 59 40 .370	23 8 9 .727	8 29 .357	8 29 .316	0 .042
Oct. 26	22 45 30 .889	22 54 0 .190			8 29 .301		
Oct. 26			22 48 40 .303	22 57 9 .715	8 29 .412	8 29 .356	0 .055
Oct. 28	22 44 30 .812	22 53 0. 078			8 29 .266		
Oct. 28			22 53 41 .122	23 2 10 .475	8 29 .353	8 29 .310	0 .044
Oct. 29	22 56 7 .035	23 4 36 .330			8 29 .295		
Oct. 29			22 57 24 .712	23 5 54 .065	8 29 .353	8 29 .324	0 .030
Nov. 2	23 2 6 .579	23 10 35 .871			8 29 .292		
Nov. 2			23 7 21 .847	23 15 51 .180	8 29 .333	8 29 .312	0 .020
						8 29 .324	
				Correction for personal equation		—0 .148	
						8m. 29s.176	

RESULTS OF LEAST SQUARE REDUCTION OF OBSERVATIONS FOR LONGITUDE ST. LOUIS TO COLUMBIA.

Date 1891.	Signals Received at Columbia.		Signals Received at St. Louis.		Difference of Time.	$\Delta\lambda$	Wave and Armature Time.
	Columbia Clock. $+\Delta T$.	St. Louis Clock. $+\Delta T$.	Columbia Clock. $+\Delta T$.	St. Louis Clock. $+\Delta T$.			
Oct. 25	23h. 7m.31s.121	23h.16m.0s.396	h. m. s.	h. m. s.	8m.29s.275	m. s.	
						8 29.316	0s.041
Oct. 25			22 59 40.369	23 8 9.726	8 29 .357		
		22 54 0 .193					
Oct. 26	22 45 30 .894				8 29 .299		
						8 29.354	0 .054
Oct. 26			22 48 40.309	22 57 9.717	8 29 .408		
		22 54 0 .073					
Oct. 28	22 44 30 .818				8 29 .255		
						8 29.299	0 .044
Oct. 28			22 53 41.129	23 2 10.472	8 29 .343		
	22 56 7 .040	23 4 36 .328					
Oct. 29					8 29 .288		
						8 29.317	0 .029
Oct. 29			22 57 24.717	23 5 54.063	8 29 .346		
	23 2 6 .584	23 10 35 .871					
Nov. 2					8 29 .287		
						8 29.308	0 .022
Nov. 2			23 7 21.851	23 15 51.181	8 29 .330		

	8m.29s.319
Correction for personal equation =	—0 .148
	8m.29s.171

Longitude of Observatory of Washington University = 6h.0m.49s.163
Longitude of Observatory of State University of Missouri = 6h.9m.18s.334

IV. HEIGHT ABOVE SEA LEVEL.

Three determinations of the height above sea level of this Observatory have been made by three independent methods. The elevation of the front door-sill of the Boone County Courthouse in Columbia was determined by Wabash Railroad levels about the year 1868, and in 1892 the height of the bench mark at the Observatory was determined by reference to the courthouse door sill. The second determination was derived from four years of daily barometric observations made at the Experiment Station on the University Grounds and compared with similar observations made at St. Louis and Kansas City, Mo. In June, 1893, the elevation was again determined by running a line of levels from the Observatory to a bench mark of the Mo. Riv. Com. located on the north bank of the Missouri river at Providence, Mo.

The Railroad Levels. The record of these levels has been burned but I have been able to secure the necessary data through the kindness of Professor G. C. Broadhead, formerly State Geologist of Missouri, and now Professor of Geology in this University. In a letter dated April 20th, 1874, written to Prof. Broadhead by Mr. Geo. C. Pratt, a civil engineer, then in the employ of the Wabash Railroad Co., it is stated that Mr. Pratt found from inspection of the records then on file in the offices of the company, that the elevation of the "Columbia Courthouse" above the St. Louis City Directrix was 342 feet. Assuming the height of the Directrix to be 405 feet, Mr. Pratt gives 747 feet as the elevation above sea level of the courthouse. The elevation of the St. Louis Directrix has been very accurately determined by the Miss. Riv. Com. and found to be 412.7 feet above mean tide level on the Gulf of Mexico at Biloxi, Miss. This result has been confirmed by the U. S. Coast and Geodetic Survey, and gives as the height of the courthouse 755 feet. The Observatory Bench Mark is 24 feet lower than the door-sill of the courthouse, and therefore we get as the elevation above sea level of the Observatory Bench Mark 731 feet.

Barometric Determination. A station of the U. S. Signal Service (Weather Bureau since 1891) was established in the building of the Experiment Station on the University grounds in Columbia during the summer of 1889, and observations were commenced on August 21st. Since that time observations have been regularly made each day at 7 p. m. central time, simultaneously with observations made at the other meteorological stations in this region. The yearly means of observations of the barometer and thermometer furnish data for the determination of differences of height. Through the kindness of the officers of the Weather Bureau I have been furnished with the monthly means of the readings of the barometer and the attached and external thermometers during the period September 1st, 1889, to September 1st, 1893, for the stations at Columbia, St. Louis and Kansas City, Mo. Using Laplace's formula for the purpose as given in the *Mechanique Celeste*, I have computed the difference of elevation between the barometer at Columbia and those at Kansas City and St. Louis for each one of the 48 months. The observations at Columbia and St. Louis give the height of the Columbia barometer above sea level as 779 feet. The observations at Columbia and Kansas City give 776 feet, and the mean, 777.5 feet, is adopted. The Observatory Bench Mark is 38.3 feet lower than the Columbia barometer, which gives as the height above sea level of the Observatory Bench Mark 739 feet.

Results of Spirit Levels. In June, 1893, the Board of Curators of this University appropriated a sum of money for the purpose of running a line of levels from the Observatory to a bench mark of the Missouri River Commission located in the town of Providence, about nine miles distant. In the report of the Mo. Riv. Com. for 1890, page 3396, this bench mark is designated as B. M. $35\frac{1}{2}$ and its height above the St. Louis Directrix is given as 181.523 feet. More precise levels which have since been run indicate a correction to this value of +0.141 ft. and we adopt, as the height above the St. Louis Directrix of B. M. $35\frac{1}{2}$, 181.664 feet. The work of running these levels was intrusted to two of my students, Messrs. F. B. Williams and W. L. McCrary. The instrument used is a good wye level belonging to the University. The

entire distance was gone over twice and the results of the direct and reverse levels differ by only 2.2 inches. The degree of accuracy thus indicated was attained in spite of the distance and the hilly nature of the country, and the result gives 143.03 feet as the elevation of the Observatory Bench Mark above Mo. Riv. Com. B. M. 35½. Adopting 412.714 feet as the elevation of the St. Louis City Directrix we have as the elevation above sea level, of the Observatory Bench Mark, 737.41 feet.

The Observatory Bench Mark is a cross, cut in the west end of the stone sill of the north basement window of the Observatory building.

The foregoing results for the elevation of the Observatory B. M. may be summarized as follows:—

From R. R. levels, 731 feet.
From Barometric Obs'ns, 739 feet.
From Spirit Levels, 737.41 feet.

The first two determinations serve merely as a rough check upon the last, and we have as the adopted elevation above sea level of the Observatory Bench Mark —

737.41 feet.

Mr. Williams and Mr. McCrary determined the elevations above sea level of several other points on or near the University campus. For convenience of reference they are inserted here.

	Height Above Sea Level.
Observatory Bench Mark	737.41 feet.
B. M. on water-table of Physics and Engineering Building	745.73 "
B. M. on water-table of Chemical Building	746.61 "
B. M. on water-table of Experiment Station	773.12 "
Front door-sill of Boone County Courthouse	761.08 "

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MERYCISM REGARDED IN THE LIGHT OF ATAVIC TENDENCY — REPORT OF A NEW CASE WITH RESULTS OF AN INVESTIGATION OF ITS DIGESTIVE CHEMISM.

EDWARD C. RUNGE.

Issued May 7th, 1894.

MERYCISM REGARDED IN THE LIGHT OF ATAVIC TENDENCY — REPORT OF A NEW CASE, WITH RESULTS OF AN INVESTIGATION OF ITS DIGESTIVE CHEMISM.

By Edward C. Runge.

Before entering upon the discussion of the possible or probable causal factors leading to the establishment of the habit of rumination in man, I prefer, as a matter of convenience, to present first the case that has come under my observation, and all that pertains to it.

Mr. D—, a gentleman of Scotch-English parentage, aged thirty-seven, high grade teacher, married but without issue, came to me on December 18th, 1893, seeking relief from an attack of indigestion. The train of symptoms complained of, was the usual: mental unrest and languor, headache, quite severe vomiting of a "bilious" nature, eructations of odorless gas, a sensation of fullness after eating, loss of appetite, but no pain. The patient stated that he had been subject to similar attacks for many years; they even compelled him to interrupt his collegiate course for one year. The attacks had usually yielded readily to dietetic measures, and some anti-fermentative medication. Four years ago, the diagnosis of gastrectasis was made. I found that this conclusion had been reached by the general appearance of the case, and not by a thorough physical examination. In the course of my inquiry, the patient mentioned quite incidentally that he had been regurgitating his food after nearly every meal for many years. Upon pressing the subject, which the patient seemed to resent as irrelevant to the main issue in question, i. e. his present complaint, I learned that the so-called regurgitation served the specific purpose of remastication. The conviction of being face to face with a simon-pure case of merycism, filled me with warrantable pleasure,— I say "war-

rantable," for the man himself had acquired the bias of looking upon this phenomenon as an integral part of his physiological make-up, and seemed to be rather surprised when I called his attention to the striking analogy existing between himself and the quadrupeds that "chew their cud." On repeated cross-questioning, I ascertained that the case had never before been placed on record.

The family history fails to record the existence of another merycole, or of any pronounced neuropathic tendency, but a weak stomach appears to have been a family heir-loom, for both parents, one aunt and a brother had been or are possessors of such a stomach. The patient is a man of that wiry type, the delicacy of appearance of which, is belied by a remarkable amount of physical endurance and nerve power. His height is 5′ 5″; his weight is with slight temporary variations about 120 lbs., pointing to a constant state of nutrition. He never used tobacco in any form, and does not indulge in alcoholic beverages, except in an occasional glass of watered white wine. He cannot remember of having ever passed through any sickness of a serious nature, and at present does not reveal symptoms of any disorder of the nervous system, except an atony or muscular insufficiency of his stomach, and particularly that of its cardiac sphincter, a condition usually classified with the disturbances of function or neuroses.

My patient's recollections of the dawn of his ruminating life carries him back to the fields and woods of his native Scotland, where he, a lad of twelve, indulged in the ingestion of unmeasured quantities of bramble berries. To this indulgence, he ascribes the establishment of the ruminating habit, acknowledging at the same time, to have been always a fast eater, which by inference fastens upon him the vice of insufficient mastication. During twenty-five years, his food had come up to a greater or less extent after every meal, to be subjected to further mastication, and then to be swallowed again. This procedure is often repeatedly gone through with from a few to about one hundred minutes after the meal. The grosser portions of the food are selected with remarkable precision: meat and seed-fruits seem to be particularly prone to be returned, vegetables and

bread less often, crackers when ingested in pieces of considerable size; the casein of the milk is regurgitated in lumps whenever milk is swallowed in large draughts. Peptonized milk, beef-peptones and fluids of any kind are never regurgitated. The taste of the regurgitated food assumes but rarely a disagreeable character; it is quite unaltered when regurgitation occurs soon after the meal, and becomes of an acid nature of varying intensity, whenever the process takes place some time after, the patient not being able to define the exact time. On March 21st he visited me at 3:30 p. m., after having partaken of a dinner at 2:20 p. m. The fish eaten at the latter was regurgitated and remasticated during our conversation. Upon questioning I found that it had not lost any of its original flavor. The act of rumination occurs nearly always without the patient's consciousness being aroused to a sense of an effort. Nausea never precedes it. Whenever the patient goes to sleep after having partaken of a heavy meal, he usually awakens with a sensation of great discomfort, and the regurgitations, on these occasions, are apt to be of a very distasteful nature. For this reason he avoids sleep on a full stomach. Past experience has taught him that he is at his best when he spends about three-quarters of an hour after eating in restful conversation, during which time the rumination is at its height; after that, a long walk seems to add greatly to the feeling of general well-being.

As a peculiar feature I may mention the following observation made by the patient on repeated occasions: whenever the ruminating act failed him, for some occult cause, he invariably suffered with regurgitation of bile into the stomach. I had an opportunity of verifying the truth of his observation, on, at least, one occasion. At our first meeting, he stated that the regurgitation had been deficient for some days. I expressed the stomach, using a soft rubber tube, and found the expressa intermixed with bile, the presence of which was clearly demonstrated by Gmelin's test for bile pigments. This fact would almost point to a remarkable interrelation existing between the insufficiency of the cardiac and that of the pyloric end of the stomach, appearing perhaps less remarkable if we consider the wonderful play of nerve in-

fluences, during the normal process of digestion in the course of which we are justified in assuming that inhibitory and augmentatory stimulation constantly alternates between the two sphincters.

The physical examination made with reference to the condition, complained of at the time of the patient's first visit, was not expected to throw much light on the normal behavior of the stomach. I concluded to abide my time, and to relieve, if possible, the temporary disturbance. A course of matutinal auto-lavage was instituted, a procedure of no difficulty as the tube had to overcome but a slight pharyngeal reflex, and descended almost by its own weight. I had occasion to take note of the ease with which the patient is able to relieve his stomach of its contents. The effort of effecting this, never assumes the vehemence of a vomiting act. A trial meal was administered, and expressed one hour after ingestion. The stomach contents showed the presence of traces of free hydrochloric acid and of a large amount of lactic acid or lactates. This led me to prescribe large and frequent doses of the dilute hydrochloric acid. Peptonized milk and beef peptones were allowed in small quantities at short intervals, until the abatement of the acute symptoms warranted an increase of the nitrogenous diet. The carbohydrates were at first excluded and only very cautiously introduced into the daily regimen. Acting upon a hint from the patient as to his having always been benefited by a long tramp into the country, I advised him to purchase a bicycle by the use of which I intended to act more forcibly and directly upon the abdominal muscles, for a flabby abdomen is, undoubtedly, an important factor in bringing on permanent dilatation of an already atonic stomach. The existence of some muscular insufficiency was suspected by me from the very beginning; that my suspicion was not groundless, was fully borne out by my further investigation. On this line of treatment, the patient gradually improved, and at present his health is restored to its usual equilibrium, which of course does not mean that the gastric insufficiency has been removed. The treatment did not affect Mr. D—'s ruminating pro-

pensities in any way; it was not intended to do so, for I followed, with regard to this feature of the case, the doctrine of letting well enough alone. I, of course, insisted all along, on a thorough primary mastication. Whether this will have ultimately the beneficial effect of eradicating the ruminating habit, remains to be seen; thus far no change is noticeable.

Having done my duty by my patient, I now called on him to do his by me, to which call he most graciously responded. On March 24th, I subjected him to another physical examination, with the following results: Inspection, palpation and percussion revealed nothing of any moment. On auscultation, with the stethoscope placed below the xyphoid cartilage, Metzer's "Durchspritzgeraeusch" (Ewald's 1st deglutition murmur) was audible once out of four times, the Durchpressgeraeusch" (Ewald's 2nd deglutition murmur) was perceptible three times out of four, i. e. when the first could not be heard.

250 cc. of water were poured into the stomach by means of the tube; in the standing posture a line of dullness appeared 4 cm. over the umbilicus. The addition of 500 cc. brought the line of dullness to within 2.5 cm. of the umbilicus. The patient complained of a sensation of fullness, and the stomach was emptied. After this, distention with air was attempted. At every stroke of the double-bulb apparatus, the air rushed out along the sides of the tube, with an explosive sound. This fact and the great discomfort complained of by the patient prompted me to desist from any further attempt at distention.

Thus far my examination proved to me three points:—

1. The absence of any considerable degree of gastrectasis.

2. The high degree of paresis or insufficiency of the cardiac sphincter.

3. Some muscular atony of the whole organ.

To establish the degree of motility of the stomach, Ewald and Sievers' salol test was made use of:—

March 25th, the salicyluric acid reaction was obtained two hours after ingestion.

March 31st, the reaction appeared two hours after ingestion and failed to show twenty-four and thirty-two hours after.

April 8th, traces of the acid were demonstrable two and sixteen hours, and none was present in the urine passed twenty-four and thirty hours after ingestion.

The last dose of the salol was taken during a meal consisting of boiled chicken, farina egg pudding and a glass of dilute white wine. The patient was at my office three hours five minutes after this meal. As he spoke of experiencing a sensation of gastric fullness, I expressed the stomach and found the contents strongly impregnated with the characteristic salol odor. In giving the results of this test, due reservation is made for the possible fallacies pointed out by some observers, and admitted by Dr. Ewald himself.

[Whoever has done any work in the physiologico-chemical line, will appreciate the importance of acute discernment of different tints and hues, for much of the accuracy in this work depends upon the possession of that faculty. For the benefit of the inexperienced in that special work, I mention the occurrence of an optical phenomenon in connection with the salol test. The color of a drop of Ferric chloride solution, appears on white filter paper, a greenish-yellow which has for its complement "violet." The latter appears very quickly on retinal exhaustion for the greenish-yellow. As the crucial test for the salicyluric acid, is the appearance of a (usually faint) violet color, the possibility of an error is obvious. My advice is to either trust to the first quick glance, or to repeat the test upon complete disappearance of the negative after-image.]

To test the absorptive power of my patient's stomach, I followed Penzoldt's suggestion, i. e. giving 0.1 gram of potassium iodide, and timing its appearance in the saliva.

March 25th it appeared one hour, and one hour and fifteen minutes after ingestion.

March 31st it had not appeared after one hour and thirty minutes.

April 8th it appeared after one hour and fifteen minutes.

I give these results with some misgivings as my patient's ruminating faculty renders them unreliable; the saliva may have been contaminated by regurgitated food particles carrying with them some of the iodide.

The method pursued in the investigation of the digestive chemism was the following: —

Having ascertained that no acid of any kind had been taken for at least sixteen hours, Ewald's test breakfast consisting of thirty-five grams of dry white bread, and one-third of a liter of warm water, was administered on an empty stomach, and the latter expressed one hour afterward. The expressa were filtered, the residue weighed, the filtrate measured and subjected to an analysis. For the sake of simplicity, I place the conditions or substances tested for, in juxtaposition to the reagents or tests employed:

Reaction = litmus paper.
Free acid = tropaeolin solution.
Lactates, lactic and fatty acids = Uffelmann's reagent.
Acetic acid = by its odor.
Acid salts = Leo's method.
Free hydrochloric acid = Gueuzburg's reagent.
Total acidity = titration with an empirical potassium hydroxide solution (1cc = 0.002532 g. hydrochloric acid), the potassium hydroxide having been previously purified by the Barium method. Phenol-Phtallein was used as indicator.
Bile = Gmelin's test.
Starch and Erythrodextrin = Lugol's solution.
Maltose = Copper reduction test.

Thus far, the examination was conducted pretty much on lines laid out in Dr. Ewald's treatise on Diseases of the Digestive Tract. With regard to the manner of ascertaining the presence of the different proteid substances in the stomach contents, I was impelled to deviate from the course advocated and commended by the professor of Berlin. On pages 42 and 43 of the authorized American edition (1892), and on pages 59, 60 and 61 of the third German edition (1893), appears a statement reiterated three times in rapid succession, to the effect that syntonin when present in the stomach contents in solution is coagulable by heat. This is one of those remarkable slips, which even the greatest of mortals are sometimes guilty of, the more remarkable as it occurs with regard to a matter of extremely fundamantal nature. If an eminent chemist had asserted and re-asserted in a treatise on

Inorganic Chemistry that barium sulphate were precipitable out of its solution in water by hydrochloric acid, the error could not have been more inexplicable than the one committed by Dr. Ewald. Syntonin and all of the other so-called derived albumins and albuminates possess the indisputable properties of being insoluble in water, salt solutions and alcohol but soluble in dilute acids or alkalies, of not being coagulated while in solution at any temperature whatever, be it 70° or 212°, and finally of being precipitable by careful neutralization. The neutralization-precipitate (Mulder's protein?) is indeed coagulable at 70°, when suspended in water or any other neutral medium. If the series of lectures which Dr. Ewald's book is a compilation of, had been held before a body of physiologists, this lapsus could never have been perpetuated in printer's ink. But the very fact of their having been delivered before an assembly of practicing physicians, renders the error the more flagrant, as the statements coming from such oracular authority, are not apt to be called in question, particularly if they refer to matters of a purely physiological or physiologico-chemical nature. Looking over the first part of Dr. Ewald's "Klinik" (Die Lehre von der Verdauung), I fail to find the slightest allusion made to any new experimental evidence, bearing out the stand taken by him with regard to the properties of acid albumin or syntonin. In the next revised edition of Dr. Ewald's work, we may justly hope to find an explanation for his attitude, or to have him acknowledge his mistake with a graceful "pater, peccavi!"

The method which I have adopted for separating the different members belonging to the family of proteids, is grounded on the results of the experimental work of the best observers in this special line. To prove that it is a working method, I give it in extenso:

1. Boil the filtered stomach contents.

Turbidity shows the presence of native proteids (albumins, globulins).

Filter.

2. Test the reaction of the filtrate with litmus paper; if acid, neutralize exactly, using as indicator, litmus or turmeric

paper. (To avoid an excess of the neutralizing reagent, it is best to use normal or empirical sodium carbonate solution, the total acidity for a certain quantity of stomach contents, having been estimated previously by titration.)

A precipitate indicates acid albumin.

Boil and filter.

3. Test filtrate for the cuproproteic reaction.

If a rose-red coloration appears, add a few drops of acetic acid, and to the almost boiling filtrate from 2, add solid ammonium sulphate to saturation (97.5 parts of the salt to 100 parts of stomach contents).

A precipitate proves presence of albumoses.

Filter after 24 hours.

4. Test filtrate for cupro-proteic reaction:

If a rose-red coloration appears, crystallize out some of the ammonium sulphate, and filter. If with nitric acid a yellow coloration, and with ferrocyanide of potassium and acetic acid no precipitate is obtained, the presence of peptones is proved.

I call attention to the following points in this scheme:—

The stomach contents are boiled at once after expression and filtration, so as to destroy the action of the gastric enzyme.

In testing for derived albumins, the use of an indicator in solution is not advisable on account of the color reactions to be made subsequently.

The term acid albumin is substituted for syntonin as used by Ewald. The latter term is reserved by the overwhelming majority of physiologists and chemists for the substance formed by the action of dilute acids on muscle myosin (Hermann,* Gad and Heymans,† Steiner,‡ Landois and Stirling,§ Foster,‖ Roehmann,¶ Beilstein**). We may well retain "acid albumin" for a generic term.

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* Hermann, Lehrbuch der Physiologie, 1892.

† Gad & Heymans, Kurzes Lehrbuch der Physiologie des Menschen, 1892.

‡ Steiner, Grundriss der Physiologie des Menschen, 1890.

§ Landois & Stirling, Textbook of Human Physiology, 1886.

‖ Foster, Textbook of Physiology, 1891.

¶ Roehmann, Anleitung zum Chemischen Arbeiten, 1890.

** Beilstein, Handbuch der Organischen Chemie, 1890.

The filtrate from 2 is boiled so as to throw out any egg albumin that might not have been coagulated by the first heating on account of the presence of the acid.

For the cupro-proteic reaction, Wenz * recommends the use of a 15 p. c. sodium hydroxide solution, and a 0.2–0.5 p. c. cupric sulphate solution added drop by drop. I prefer not to name the rose-red cupro-proteic reaction a "Biuret" reaction for the reason that a lamentable confusion exists with regard to this term: some physiologists apply it to the violet and rose-red cupro-proteic reactions, others limiting it to the latter. Biuret is a nitrogenous decomposition product obtained on heating urea to 120°. It responds to many reactions characteristic to proteid bodies, hence Pickering † recommends the use of the term "Biuret" in a generic sense. He offers at the same time new terms for the two cupro-proteic reactions: for the violet—"iono-proteic" (ἴον — a violet), and "rhodo-proteic" for the rose-red reaction (ῥόδον — a rose). The popularization of this proposed change should be hailed with gratification by all who have truly scientific terminology at heart. In quoting Pickering I take pleasure in mentioning his recommendation of the sulphate of cobalt as a delicate reagent for detection of proteid bodies. The colors struck by it with the different proteid bodies are so characteristic as to preclude any possible error of discernment, while that much cannot be said of the violet and rose-red of the cupro-proteic reaction.

For the separation of the albumoses of which Ewald in his scheme mentions but one, the propeptone of Schmidt-Muehlheim, or Kuehne's protalbumose, I modified Ewald's procedure by substituting saturation with ammonium sulphate for the saturation with sodic chloride on addition of acetic acid. Wenz ‡ has satisfactorily demonstrated that ammonium sulphate, under certain conditions, will throw down all proteids except the true peptones. Ewald follows the method recommended by Boas, the results of which Chittenden § has proved to be without

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* Wenz, Zeitschrift f. Biologie, Vol. XXII.

† Pickering, "Proteid Reactions," Journal of Physiology, Vol. XIV., 1893.

‡ Wenz, Zeitschrift f. Biologie, Vol. XXII.

§ Chittenden & Hartwell, "Proteoses & Peptones," Journal of Physiology, Vol. XII, 1891.

any value for the reason that sodic chloride will precipitate protalbumose but will not affect in the least the deuteroalbumose. The latter would pass into the filtrate from 3, and thus vitiate the results of the subsequent tests for peptones.

Reverting to the case under consideration, I will state that Ewald's test breakfast was administered on six different occasions. The expressa obtained on March 27th were rejected on account of a distinct odor of sulphuretted hydrogen, the presence of which would have vitiated Guenzburg's reaction and the results of the estimation of total acidity. The patient admitted having eaten some eggs on the previous day which may have been not quite fresh. It has been urged by Vierordt * and others that Ewald's trial meal left room for considerable error by putting the working capacity of the stomach to but a slight test. To meet any objections on that score, I added to the breakfast in Exp. VII and VIII the white of two hard boiled eggs.

The results of the analysis were as follows:—

	March 25	March 27	March 29	March 31	April 1	April 4	April 17	April 22	
Exp.	I	II	III	IV	V	VI	VII	VIII	
Residue.....	5.99		4.51	3.85	6.73	5.20	3.82	6.90	grms
Filtrate.....	46		36	47	36	42	46.5	52	cc.
Reaction.....	acid		acid	acid	acid	acid	acid	acid	
Free acid.....	pres.		pres.	pres.	pres.	pres.	pres.	pres.	
Lactic and fatty acids.....	abs.		abs.	abs.	abs.	abs.	abs.	abs.	
Acetic acid....	abs.		abs.	abs.	abs.	abs.	abs.	abs.	
Acid salts.....	trace		trace	abs.	abs.	abs.	abs.	abs.	
Free hydrochloric acid .	2.203		1.499	1.694	1.418	1.747	1.514	1.932	p. m.
Starch	pres.		abs.	abs.	abs.	abs.	abs.	abs.	
Erythrodextrin	pres.		pres.	pres.	pres.	pres.	abs.	abs.	
Maltose.....	pres.		pres.	pres.	pres.	pres.	abs.	pres.	
Native proteids	abs.		abs.	abs.	pres.	pres.	pres.	pres.	
Acid albumin ..	abs.		pres.	pres.	pres.	pres.	pres.	pres.	
Albumoses....	abs.		abs.	abs.	?	pres.	pres.	pres.	
Peptones.....	pres.		pres.	abs.	?	?	pres.	abs.	
Bile.....	abs.		abs.	pres.	abs.	abs.	abs.	abs.	

* Vierordt, Diagnostik der Inneren Krankheiten, 1889.

The residue consisted of bread pulp; no coagulated egg albumin was discoverable in the expressa obtained for Exp. VII and VIII.

The filtrate was watery, slightly opalescent, odorless or of a faint bread odor, in color yellowish, except faintly green-ish-yellow in Exp. IV.

The salient points in this list of experimental data appear to be the following:—

1. The rather close approximation of the amounts of residue and filtrate obtained at each experiment points to the thoroughness of the expression practiced.

2. The absence of any fermentative process is evident.

3. The amounts of free hydrochloric acid estimated, lie within the limits of the physiological norm, the minimum being 1.418 and the maximum 2.203 p. m. The nitrogenous addition in Exp. VII and VIII, did not affect the amount of the free acid.

4. The amylolytic action of the salivary enzyme, is demonstrated by the presence of erythrodextrin and of maltose, the latter in considerable quantities in Exp. I–VI as shown by the exceedingly vigorous reduction of the cupric oxide. In VII, no reduction took place, and in VIII, but a slight one.

5. With regard to the analysis of the changes produced by the action of the pepsin-hydrochloric acid, I candidly admit that it was instituted for the sole purpose of meeting any possible recriminations against the completeness of the work done in connection with the case under consideration, and not with the anticipation of obtaining any fruitful results. In the light of our present knowledge of gastric digestion such an analysis is of but small value as clinical evidence. At the very threshold, we are met with a veritable maze of questions: Does gastric proteolysis terminate normally in the production of true peptones? The albumoses being more closely related in molecular composition to the intravascular proteids than the peptones, are they absorbed to any extent by the mucous surface of the stomach? Does the absorptive function of the stomach play an important or an insignificant rôle during the digestive processes? These and many more perplexing questions are awaiting a satisfactory, experimental solution. At

present the clinician cannot be too cautious in drawing conclusions from the results obtained by an analysis of stomach contents. The trend of experimental evidence seems to point to but a slight absorptive power exercised by the stomach. If I accept this view, I am able to give but one interpretation to the data presented in the above table: the disappearance of a large amount of the ingesta (on the average about 30 grams out of 35) together with the presence of the proteolytic products in small quantities, points to a rather active removal of the stomach contents into the small intestine. This would go to show that the muscular insufficiency demonstrated by the physical examination is not of a pronounced character.

The intensity with which coagulated egg albumin is liquefied by my patient's gastric secretion, was tested according to the method described in detail by Ewald. The addition of hydrochloric acid, two drops to 5 cc. of stomach contents, exercised a favorable influence upon the process of liquefaction.

The chemical analysis proves clearly that the digestive chemism, in any and all of its phases, is not the causal factor of the ruminating habit in the case under consideration.

Shall I shelve the difficulty by labeling this most remarkable phenomenon with the enigmatical superscription "neurosis?" To my understanding this euphonius term appears very nearly akin to the mathematician's zero: it *is* not "nothing," but it is the symbol for nothing. I admit that we cannot entirely dispense with the term, as the dislike for nameless things is an inherent quality of our nature. What I object to, is the assumption of an oracular mien while giving utterance to it, just as if something intelligible and tangible were implied by its use. The neuroses are the offspring of our limitations. As a temporary makeshift, the term may serve its purpose, but let us hope that with further development of our means of investigation, the neuroses will gradually decrease in number, and at last disappear entirely from the field of our intellectual vision. To me merycism is not a neurosis, but what is it?

The great majority of merycoles were reported as enjoying

perfect health; except for this habit, they did not disclose any deviation from the physiological standard. In my case there is seemingly a primary muscular insufficiency of the stomach, which appears to be a product of prenatal influences, a baleful legacy of a line of ancestors afflicted with a weak digestive viscus. To prove or disprove by actual data the existence of these influences is alike impossible, as we are rarely allowed to lift the veil off the past, beyond the second generation of progenitors. Few women or men know anything about the physical condition and habits of their great-grandparents, though they may be found brimful of information as to the social, intellectual and, perhaps, moral status of their ancestry, centuries back. Does the paresis of the cardiac sphincter or the atony of the entire organ stand in any causal relation to my patient's ruminating habit? The former, as we well know, gives rise frequently to repeated and very persistent regurgitations of food. But rumination is something more than regurgitation; whenever the latter takes place, any of the stomach contents present at the time are sent up indiscriminately: at one time it may be solid food, at another chyme, or gas or fluid. In the case before us, the regurgitating act occurs with plainly selective precision; only, portions of the food that are in need of further mastication are returned with almost marvelous regularity. This feature stamps the case as one of rumination. The general atony of the organ cannot be considered seriously as a causal factor, for rumination is an act calling for actual, though perhaps slight exertion on the part of the muscular fibers of the stomach, the extrinsic abdominal muscles being never called upon to aid in the consummation of the act.

My attempts at solving the problem having failed thus far, there is but one more thing to be done, and that is to find how much or how little the process of atavic tendency or reversion to ancestral types may have had to do with the establishment of this unusual condition. Eugène Martel,* in a contribution to the Revue internationale des Sciences Médicales (1886), quot-

* Stedman, "Article on Rumination," Reference Handbook of the Medical Sciences, Vol. VIII.

ing Blanchard, says, "that the habit of rumination was acquired by certain animals at the time that the carnivora appeared upon the earth. Fearful of attack, the ruminants grazed rapidly, ready for flight at the first intimation of danger. Then, having reached a place of safety, their food was regurgitated and masticated thoroughly. A similar condition is obtaining in man, he asserts, in this age of hurry; and unless we learn to be more deliberate in our eating, and to masticate our food in the first instance more carefully, the necessities of digestion will compel a regurgitation and rechewing of the food, which has been so imperfectly prepared for the action upon it of the gastric and intestinal secretions, and in time this process which is now exceptional in man, will become habitual."

This is not fanciful in the light of the science of evolution. While we are busily working in our laboratories over flasks and test tubes, pressing into service all the innumerable devices of human ingenuity, with a view of revealing some truth, we should never grow oblivious to the work that is being done in the great universal laboratory where in accordance with the eternal laws of nature changes are wrought unceasingly, unremittingly. These changes are effected by a slow gradual process, the actual workings of which remain ever imperceptible to us. Our intellect is capable of grasping their enormity only in the retrospect. But, if on the highroad of our natural lives, we meet with a phenomenon that appears to be replete with incongruity with its surroundings, and to defy our attempts at explanation, made in accordance with our limited experiences, do not let us dismiss its consideration lightly! It may easily be one of those sudden flashes by which nature reveals her cosmic work from time to time. It will not do to refuse such thoughts entrance into the routine of our daily labors. If we disdain to apply the grand lessons taught by the science of biological evolution, we shall continue to dwell in utter darkness with regard to many vital phenomena. The laws of evolution, though all of their mysteries have not been and may never be unraveled, have been long ago cleared of the odium of idle speculation; they are as much of an incontrovertible fact as the law of gravitation.

Here we are face to face with a man who clearly abused his stomach, which, at his very birth, was branded with ancestral vice. Food which is the natural stimulant to the sensitive mucous membrane of the organ, was bolted, practically unchewed, every day of his life. From being a stimulant when offered in proper form, it grew to be an irritant, the difference lying in degree only, not in kind. The presence of irritating agents of any description is angrily resented by all tissue of high vitality: the mechanically indigestible matter was promptly rejected. This marks the phase of regurgitation. The possessor of the stomach finding the regurgitated bolus unaltered in flavor, i. e. not objectionable to his palate, subjected it to more thorough mastication. This interchanging play was repeated until the food had attained the pulpy consistency best suited for the work of digestion. This marks the phase of rumination. The bolted gross food particles gradually ceased to play the rôle of irritating agencies; habitual recurrence of the events, made them revert to their original character, i. e. they again became stimulants with the only difference that instead of inciting the churning movements of the stomach, they called forth propulsive movements that carried the offending agents along the path of least resistance, namely through the cardiac opening with its paretic sphincter. It is reasonable to assume that the nerve elements, central as well as local, acquired, pari passu, the faculty of responding to these new agencies of stimulation, and thus a complete reflex mechanism had been established. The higher brain centers were at first actively engaged in directing the process of remastication. At last they grew habituated to the changed order of things, and the entire act lost all the features essential to a conscious effort.

Thus stands before us in bold relief a beautiful illustration of the workings of atavic tendency. Our merycole bears out the biological truism that similar conditions are ever productive of similar effects, and that every living organism possesses the inherent power of adaptation. Two points may be raised against the view taken by me: firstly, it may be argued that the insignificant number of cases observed and recorded

(about 116 in all, I believe) does not warrant such conclusions as I choose to draw from them; secondly, that there never were any profound anatomical changes demonstrated, which would lend strength to the assumption that merycoles were products of the latent tendency to revert to ancestral types. As to the first objection, let me ask how are we to know that the small number of cases reported represents even approximately the actual number that have existed and exist at the present day? Might we not justly surmise, from the very nature of the phenomenon, that an untold number of merycoles have lived and still live their long and natural lives amidst the mass of teeming humanity without ever having awakened to the consciousness of deviating in any manner from the physiological norm?* Raphael Blanchard,† who is a congenital merycole, is a good case in illustration. The peculiarity of his condition never dawned upon him until a text-book of human physiology had come into his hands; but for that incident, his case might never have been placed on record. The other objection I will meet by adducing the biological fact that physiological or functional changes always precede those of an anatomical or structural nature. Thus were the semi-carnivorous incisor and canine teeth of the Artiodaktyla and Perissodaktyla subjected to gradual structural changes, after the animals had begun to feed on food of a different nature. The close relationship between structural arrangement and functional requirement is beautifully illustrated by the stomach formation of the new-born of the Selenodonta or Ruminantia, now extant.‡ Instead of the four compartments that we find in the adult animal there is but one fully developed, and that is the abomasus with its enzyme secreting mucous surface; the rumen, reticulum and omasus attain their full development during the first period of the animal's

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* The strong plausibility of this assumption has been forcibly impressed upon my mind since the reading of this report. A gentleman of high scientific repute, upon hearing of my case, volunteered the information that he had been a merycole for a long time. His case has never been recorded.

† Stedman, "Article on Rumination," Reference Handbook of the Medical Sciences, Vol. VIII.

‡ Wiedersheim, Lehrbuch der Vergleichenden Anatomie der Wirbelthiere, 1886.

extra-uterine life. Our domestic calf does not ruminate while suckling. The mechanism of rumination is set to going at once when the nature of the food is changed. If merycoles have not so far borne out anatomically the theory of atavism, that does not preclude the possibility of gradual structural adaptation to the altered functional requirements. It must never be lost sight of that all evolutionary transformations, be they progressive or revertive in nature, are extremely gradual, and that we should not measure evolutionary processes with the infinitesimal measure of the few thousand years of historical record. We should remember that eons of time lay behind us, and that eons are to come!

In conclusion I will say that — atavism or no atavism — human rumination, if genuine, is not a pathological entity, but a physiological anomaly. It appears anomalous by comparison with the habits of the overwhelming bulk of non-ruminating members of the human family. With most merycoles it assumes the form of a perfectly natural process, essential to their individual well-being, any interference with which is frequently followed by disturbances of a truly pathological nature. I frankly confess to sharing fully Eugène Martel's view, which appears rational in the light of many other manifestations of nature's willing responsiveness to use, abuse and disuse.

The chemical work, in connection with this report, was done at the physiological laboratory of the St. Louis Medical College.

I take pleasure in thanking Dr. John Green, of the faculty, for the encouragement he has given me by word and deed, and which he is always ready to proffer whenever and wherever earnest work is being done.

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THE POST-MORTEM DETECTION AND ESTIMATION OF STRYCHNINE.

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE WASHINGTON UNIVERSITY.]

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THE POST-MORTEM DETECTION AND ESTIMATION OF STRYCHNINE.

By Allerton S. Cushman.

In the post-mortem detection and estimation of strychnine the greatest difficulty which presents itself is the separation of the alkaloid from the various extractive fatty, sugary, and pigmentary matters derived from the stomach contents or organs under examination. The fact that such small doses as 32 mg. ($\frac{1}{2}$ grain) and 48 mg. ($\frac{7}{10}$ grain) of the sulphate of strychnia have in two well authenticated cases proved fatal,* and also that absorption and distribution of the poison through the system begins as soon as it is administered, makes the problem set before the chemist one of unusual difficulty. In case death has occurred with all the well defined symptoms of strychnine poisoning in the course of an hour or two after the first signs of sickness appeared, the contents of the stomach and bladder generally account for a sufficient quantity of the alkaloid to substantiate the diagnosis. Sometimes, however, strychnine has to be sought in exhumed remains, where the evidence as to symptoms or duration of sickness is incomplete or vague. In such a case it has been doubted by some toxicologists that strychnine could be detected at all after long burial and the consequent advanced decomposition of the body. In contradiction of this opinion is the experience of A. H. Allen,† who found the alkaloid in the dust of decomposed human viscera which had lain in a charcoal stoppered vessel for six years. Again lately W. A. Noyes‡ detected strychnine in an exhumed body after it had been buried for 308 days.

The danger of error has also been noted from the forma-

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* Blyth — Poisons, Effects and Detection.

† Commercial Organic Analysis, Part II, Vol. III, p. 376.

‡ Jour. Am. Chem. Soc., Vol. XVI, No. 2.

tion of cadaveric alkaloids or ptomaines in decomposed bodies which may in some of their reactions simulate the reactions of strychnine. While this is probably true it is impossible that any chemist would submit an opinion on a case of strychnine poisoning unless all possible tests, chemical, physiological, and morphological had first been tried, and it is hardly likely that any alkaloid substance other than strychnine itself could be mistaken for it.

In all of the literature on strychnine and its post-mortem separation but little attention is paid to the estimation of quantity, most authorities appearing to consider the detection of the alkaloid sufficient. Undoubtedly where death has occurred accompanied by well defined ante-mortem symptoms the finding of even much less than the usual fatal dose would seem to be conclusive, since the poison which actually caused death has undoubtedly been distributed and absorbed in doing its work. Quantitative evidence is, however, always valuable and sometimes indispensable before an opinion can be formed or submitted in evidence before a jury.

In the usual method of analysis the material to be examined is extracted with alcohol and some acid. The aqueous residue that remains after filtering and evaporating off the alcohol is diluted and filtered, necessitating an examination of both filtrate and residue for the alkaloid, the residue sometimes carrying more than the filtrate.* The filtrate is then evaporated, the extraction with alcohol repeated, and the filtrate finally made alkaline and extracted with chloroform. The chloroform never separates well from the alkaline liquid at this point except on long standing, besides which it takes up large quantities of extractive matters and oily bases which completely hide the strychnine when the chloroform is evaporated. The strychnine is separated from this mass by digesting with concentrated sulphuric acid at 100° C. As the strychnine as well as the extractive mass is partly decomposed by this method,† it is very unsatisfactory, since when very small amounts of the sample are submitted, the utmost economy in work is necessary.

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* Jour. Am. Chem. Soc., XVI, No. 2.

† Ber. der Chem. Ges. XVIII, 3429.

The following method modified from the usual methods has been found by us in every case to yield excellent results. The stomach contents or viscera properly comminuted are weighed and an aliquot part taken for analysis. The mass is digested in a beaker over night at a warm temperature with water acidulated with acetic acid. The contents of the beaker are filtered by pressing through muslin, and then passing through paper. The clear filtrate is evaporated on the water bath to soft dryness, an excess of ordinary 80 per cent. alcohol added and boiled ten minutes with stirring and allowed to stand one-half hour at a warm temperature. This extraction is repeated, the alcohol extracts united, filtered, evaporated to soft dryness, and the residue taken up with a little water acidulated with acetic acid, and shaken out with pure acetic ether in a separating funnel. Successive fresh portions of acetic ether are used until the solvent shows by its color and by the evaporation of a few drops that it does not contain extractive matter. As many as twelve extractions are sometimes necessary to accomplish this. Care should be taken in each case to allow time for as complete separation as possible between the two layers. The purified acid aqueous liquid, which need not exceed in bulk 50 c.c., is now returned to the separator, an equal quantity of fresh acetic ether added and enough sodic carbonate in solution to render the mixture slightly alkaline, and the separator is then thoroughly shaken for several minutes. All the alkaloid should now be in solution in the acetic ether, but a second shaking of the alkaline liquid, with acetic ether is always made, the two extracts united and evaporated in a glass dish over hot water to dryness. It will now be found that the residue shows the alkaloid fairly pure but not pure enough for quantitative results. The residue is dissolved in a few drops of dilute acetic acid, warmed to complete solution, filtered if necessary, diluted to about 30 c.c., and the solution transferred to a small separating funnel. Thirty c.c. of ether-chloroform (1-1) are now added and the separator shaken. After separation the heavier ether-chloroform is allowed to run off, another lot of 30 c.c. of ether chloroform is added, the separator shaken, and immediately enough ammonia water

added to render the mixture alkaline, and the whole vigorously agitated for several minutes. After separation is complete the ether-chloroform layer is run out into a clean 50 c.c. glass stoppered burette. The alkaline water solution is agitated with 20 c.c. more of the ether-chloroform, separated and this extract added to that in the burette. The burette is now supported over a small weighed glass dish which is kept warm on a water bath and the liquid allowed to evaporate gently drop by drop until a sufficient quantity of the pure alkaloid has collected in the center of the dish to render an accurate weighing possible, or else all of the alkaloid may be collected and weighed at once. After all possible tests have been made upon the weighed alkaloid the remainder is redissolved in a drop or two of acetic acid, a little water added, and the dish exposed under a bell glass to the fumes of ammonia. After standing some time all the strychnine is found crystallized out in the beautiful characteristic needle-formed crystals. The mother liquor is drawn off with a small fine pointed tube and rubber bulb, the crystals carefully washed with a little water and dried over sulphuric acid. The glass dish containing these crystals is kept as the final exhibit and is shown in evidence. Another convenient exhibit may be prepared by moistening a small filter paper with a solution of the alkaloid in dilute acetic acid, then moistening with a solution of potassium dichromate; this paper on being dried may be kept indefinitely. On moistening it and touching it at any time with a drop of strong sulphuric acid a violet film changing to cherry red is formed at the place of contact.

The point which seemed most doubtful in using the above method of analysis was whether, after making the purified extract alkaline and shaking in the separating funnel with acetic ether, the solution of the alkaloid would be complete. Experiments were undertaken to investigate this point, and it appeared that if the alkaloid was precipitated in the presence of the solvent the solution was so complete that no trace of strychnine could be found in the alkaline water residue, nor could any bitter taste be detected. In order to test the general efficacy of the method a mixture was made up in the laboratory of starch, glucose, cane sugar and lard with

85 per cent of water. Four lots of about 100 grams each were measured out into breakers. Into each of the first two of these was weighed exactly 25 mgs. of a sample of Merck's strychnine sulphate, which I satisfied myself by careful analysis to have the formula $(C_{21}\ H_{22}\ N_2\ O_2)_2\ H_2\ SO_4 ; 5H_2\ O$. Twenty-five mgs. of this salt were therefore equal to 19.5 mgs. of the alkaloid. One analysis yielded 19.4 mgs., the other 19 mgs. of the alkaloid, an average of 98.4 per cent. Into each of the other two breakers 20 mgs. of pure strychnine alkaloid was weighed. One analysis yielded 17.6 mgs., the other 18.6 mgs., an average of 90.5 per cent.

The next trials were made on a mixture of 200 grams of meat-hash, 50 grams sugar, 5 grams starch and 500 grams water. Into this 80 mgs. of the pure alkaloid dissolved in a little dilute acetic acid was thoroughly stirred and the mixture set away in a warm place for two weeks. At the end of this time the whole mass was weighed and portions taken for analysis, the analyst being unaware of the amount of strychnine that had been added. The results of the analysis were as follows: —

Total weight of mixture..... ..... 753 grams.

I. 216 grams of mixture gave 20.1 mg. strychnine.
II. 287 " " " 25.6 mg. "

Calculated for 753 grams mixture.

	I.	II.	Actually weighed in
Mgr.....	70.07	67.17	80
Grains.....	1.08	1.04	1.23
Per cent recovered.....	87.8	86.2	

As a result of these experiments we are led to believe that the method as described can be depended upon to recover more than 85 per cent of the amount of strychnine present in complex organic mixtures.

The method has been used in working on two separate cases of suspected strychnine poisoning, in both of which the alkaloid was easily detected.

Case A. The case of a woman who was taken sick directly after drinking a glass of beer, in which poison was supposed to have been put. She was soon after seized with tetanic convulsions and died within an hour. The stomach was removed within a few hours after death. The total weight of the stomach contents as submitted to us was 261.3 grams or 8.4 fluid oz.; 77.2 grams taken for analysis yielded 10.1 mg. of the pure alkaloid, equal to .53 grains in the whole amount of 8.4 fluid oz. Another analysis on 90.7 grams of the material yielded 10.4 mg., equal to .46 grains in the whole amount. The detection of $\frac{1}{2}$ grain of the alkaloid in 8.4 fluid oz. of the stomach contents was in this case a complete substantiation of the diagnosis of death from strychnine poisoning.

Case B. In this case strychnine had been administered in a glass of whisky, death following in about an hour with convulsions. The stomach was removed the next day. As submitted for examination the stomach contents weighed 643.6 grams, equal to 20.7 fluid oz. One analysis yielded an amount of the alkaloid equal to .66 grains, another an amount equal to .71 grains for the whole sample. The 21.7 fluid oz. of stomach contents contained therefore at the lowest estimate .66 or $\frac{2}{3}$ grains of strychnine alkaloid.

It may be said that in the two cases as described the conditions were unusually simple, death having occurred with well defined symptoms. No antidotes were used and no decomposition had taken place in the samples when analyzed. If narcotic alkaloids such as morphine have been used as antidotes to the strychnine poisoning, or if much decomposition has taken place in the body with the formation of cadaveric alkaloids, both quantitative and qualitative results may be to some extent interfered with. Morphine, however, on account of its very limited solubility in ether-chloroform could only appear as traces in the final strychnine residue obtained by this method. Whereas if much decomposition had taken place the presence of ptomaines would be at least suspected and the question of the purity of the final residue very carefully considered.

The qualitative examination of the weighed residue as has already been pointed out is divided into three groups, chemical, morphological and physiological. A minute portion of the residue is dissolved in a drop of strong sulphuric acid and touched with a moist crystal of potassium dichromate the beautiful purple oxidation product changing rapidly through crimson to cherry red immediately appears. A minute portion of the residue is dissolved in a drop of strong sulphuric acid on platinum foil. If the foil is now connected with the positive pole of a dry cell battery and the drop of acid touched with a platinum wire from the negative pole immediately the blue oxidation tint will flash out.

A portion of the residue dissolved in dilute acetic acid, the acid evaporated off, this residue taken up with water and exposed to the fumes of ammonia, gives beautiful tufts and silky needle-like crystals of the alkaloid, which can be studied with the microscope. A little of the residue dissolved in a drop of nitric acid gently warmed and touched with a minute particle of potassium chlorate produces an intense scarlet coloration.

If to a dilute acetic acid solution of a portion of the residue a drop of potassium chromate solution is added, beautiful characteristic bush-like crystals and octahaedra of the chromate are formed and can be observed under the microscope. These crystals touched with sulphuric acid give the oxidation test.

Potassium ferro-cyanide and picric acid also give highly characteristic miscroscopic crystalline forms.

A very small portion dissolved in a dilute acid and further diluted with water has a persistent and distinct bitter taste when a drop of the solution is placed upon the back of the tongue. One part of strychnine in 700,000 parts of water can be detected in this way.

As a final test the physiological effect on a frog is tried; 2.1 mg. per kilogram weight is the minimum fatal dose for a frog. For an average sized frog weighing 50 grams this means the astonishingly small amount of 0.05 mg. In our cases 1. mg. was dissolved in a drop of acetic acid, about fifteen drops of water added, and something less than one-tenth

of this solution injected under the animals' skin right over the spinal column. In both cases though the amount of strychnine administered was less than 0.1 mg., well developed tetanic convulsions occurred in ten minutes and death in half an hour.

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GEOLOGICAL SURVEY OF MISSOURI

ARTHUR WINSLOW STATE GEOLOGIST

GEOLOGIC AND TOPOGRAPHIC MAP

Surveyed in 1890.

Edition of April 1892.

HIGGINSVILLE SHEET

CORPS

ARTHUR WINSLOW, GEOLOGIST IN CHARGE
LEO GLUCK, ASSISTANT.
C.F. MARBUT, AID.

93° 45′ 93° 40′ 93° 35′ 93° 30′

39° 15′ 39° 10′ 39° 05′ 39° 00′

51 N. 50 N. 49 N.

26 W. 25 W. 24 W.

RAY COUNTY

LAFAYETTE COUNTY

MISSOURI RIVER

C. & A. R. R.

J.C. & B. Br. M. P. R. R.

L. Br. M. P. R. R.

BERLIN

DOVER

PAGE CITY

HIGGINSVILLE

CORDER

ALMA

WAVERLY

CAILLVILLE

Tabo Creek

Salt Creek

Davis Creek

Approximate Limit of Warrensburg Sandstone

Hor. Mulky Coal

Hor. of Lexington Coal

Horizon of Mulky Coal

Horizon of Lexington Coal

Scale 1/62500 of Nature

Contour Interval 20 ft.— Datum Mean Sea Level

NOTE: *The projection is that of the U. S. Geological Survey Sheet of 1885-7. The Missouri river is from Surveys made in 1879, by the Engineer Corps of the U. S. Army.*

LEGEND

COAL MEASURES

- *Lower Coal Measures*
- *Middle Coal Measures*
- *Warrensburg Sandstone*

Diagram showing section numbering in townships.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL MARKS.

- Outcrop
- Pit or Opencut
- Stripping
- Drift
- Shaft
- ⊙ D.H. Churn Drill Hole
- ⊙ D.D.H. Diamond Drill Hole
- Open well
- Geological Boundary
- Horizon Line of a coal Bed
- Building
- Ch. Church
- S.H. School House
- Sh. Shale
- S.S. Sandstone
- L.S. Limestone

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